DISCOVERY

THE MAGAZINE OF SCIENTIFIC PROGRESS

MAY 1959 216

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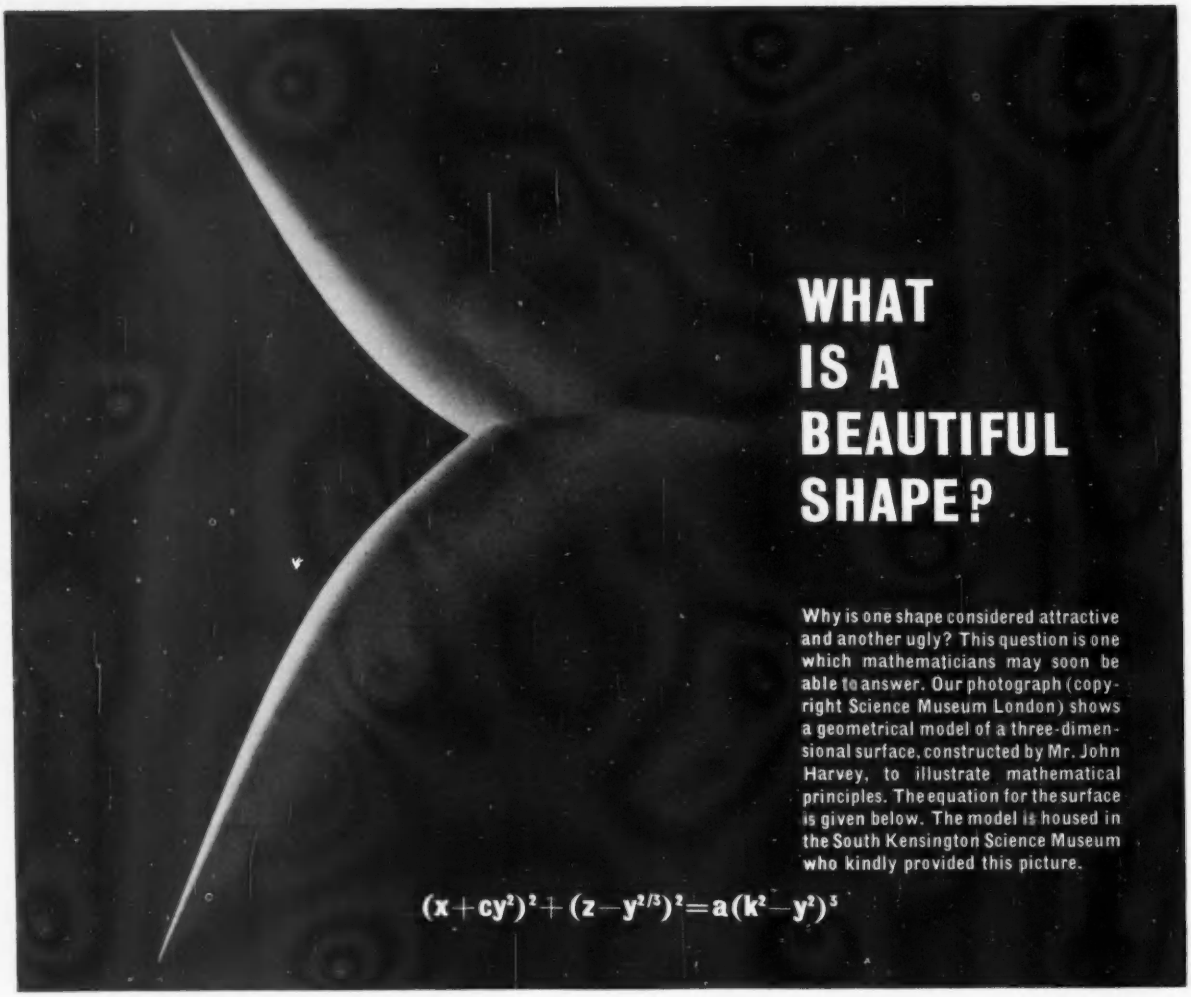

WHAT IS A BEAUTIFUL SHAPE?

Why is one shape considered attractive and another ugly? This question is one which mathematicians may soon be able to answer. Our photograph (copyright Science Museum London) shows a geometrical model of a three-dimensional surface, constructed by Mr. John Harvey, to illustrate mathematical principles. The equation for the surface is given below. The model is housed in the South Kensington Science Museum who kindly provided this picture.

$$(x+cy^2)^2+(z-y^{2/3})^2=a(k^2-y^2)^3$$

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OUR COVER PICTURE

The Wix Library at the Weizmann Institute in Israel.

CONTENTS

The Progress of Science in Israel 183
"Harness the Sun . . . Sweeten the Sea"
Search for Knowledge
Deluge the Desert
Teach Technology
Drain the Marshes
House the People
Serve Humanity
Mine the Minerals
Educate the Army
Find the Future

The Battle of the Books 198

Writing for Science 199
Geoffrey Parr, M.I.E.E.

Historic Scientific Books at Oxford 204
A. M. Wood

The Bookshelf 206

Pierre Curie (1859–1906) 219

Geophysics and Space Research 220
Angela Croome

Science on the Screen 223

Letters to the Editor 225

Far and Near 226

Seeing

is believing . . .

Old sayings, it might be supposed, have no place in the ordered, logical world of science. Yet wherever research is concerned with phenomena outside the normal limits of human perception, the reliance placed by scientists on photographic methods of rendering visible the "invisible" bears out the essential truth expressed in "seeing is believing".

The pioneers of photography (scientists too in their own right) might nevertheless find it hard to believe their own eyes were they to be confronted with some of the results of modern scientific photography—but they could not fail to recognise the amazing progress in manufacturing technique which has enabled Ilford sensitised materials to play a leading role in so many aspects of present-day research.

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THE PROGRESS OF SCIENCE IN ISRAEL

An increase in temperature and pressure accelerates many chemical reactions. Similarly, it has been observed that the solution of scientific problems can be accelerated if social pressures are increased and if the tempo of national life quickens. Outstanding examples are development of aeronautical engineering during World Wars I and II, of atomic power, of rockets, and of antibiotics. After a time, a balance seems to appear between the constructive and destructive applications of such accelerated progress of science.

Social pressures are certainly very evident in Israel. An explosive increase of its population has demanded a vast amount of agricultural land, and a housing programme of unprecedented dimensions. In a country of sand and desert, agricultural land could only be created by large irrigation schemes, in turn demanding pipes to carry the water. At present 108-in.-diameter pre-stressed concrete pipes, weighing 30 tons each, are mass produced, and Israeli engineers are acknowledged experts in this field. But every drop of available water must be used, and hence large research projects are afoot in Israel to desalt brackish ground water, and possibly later to utilise sea water.

In a country without any sizeable fossil fuel deposits, and where coal has become a museum specimen, there is naturally great pressure to develop other sources of energy, and research on solar energy is far advanced. For example, in the port of Elath, on the Red Sea, every new house has its own solar energy water heater. When, therefore, David Ben-Gurion, Israel's Prime Minister, used the phrase "Harness the sun . . . sweeten the sea", he aptly epitomised the contributions of science to the future of his country, which has set itself the difficult task in a free democracy of reaching from nothing a high standard of living.

But by themselves efficient solar energy and plentiful water for irrigation are not enough. At present there is an almost complete absence of industry in Israel, although many well-trained and intelligent scientists are available, whose work is certainly of the highest international standard. How to create local or to attract foreign capital, the second essential building stone for industrial development, is an economic and political problem and one that should not remain outside the scope of scientific method. It is doubtful if the full power of this method is appreciated in Israel at the highest level, although apparently the first steps towards it are now being considered. The many editorial pages of this journal which have been concerned with problems of this kind and possible scientific solutions, are not only applicable to England but also to Israel.

A good part of the blame that science is not fully appreciated at the highest level and also at the most popular one, must be borne by Israel's scientists themselves. Heavily engaged in research and teaching duties, they feel they may be excused if they have not played their full share in the communication of science. And yet to communicate the spirit of science through the Press and the Radio, and thus bring about a true appreciation of the most powerful force of the present century is a sacred duty which scientists of all countries neglect at their peril, and Israel is no exception.

To see Israel's problems in isolation, as a struggle for survival of a mere 2 million people on the eastern shores of the Mediterranean, is to misread completely the efforts of many young nations. For them it is the use of science which will bridge the gap between the "haves" and the "have-nots". The communication of science, the appreciation of the power of the scientific method at the highest political level, the imaginative use of scientific results and a scientific planning for the future are problems of world-wide importance; Israel may well claim to be the pilot plant for this new scientific world. In this respect it has a unique role to fulfil, and a grave responsibility to science. So far, great results have been achieved of which all Israelis are justly proud, but much remains to be done before the preliminary results of a pilot-plant experiment can be applied to full-scale use by the rest of the new world.

SEARCH FOR KNOWLEDGE

Entrance to the Weizmann Institute.

Where not many years ago there was only sand and desert, there now stands, 15 km. south-west of Tel Aviv in beautifully wooded grounds, a research institute of which Sir Robert Robinson has said "The scientific work bears comparison in its quality with the output of any similar organisation—if, indeed, such exists. The Weizmann Institute is already one of the most effective research complexes in the world." This is a tribute from an organic chemist to the Institute which bears the name of another organic chemist, who by all accounts* was a scientist of remarkable vision and foresight.

> "Weizmann believed in long-term strategy and distrusted improvisation. He believed profoundly in the application of scientific method to human life, in which England once led the world; he believed in the unlimited transforming powers of natural science. This was at the heart of his optimism, of his hope and faith in the future. As he reflected on the poverty of the land and its lack of natural resources he placed his hope upon turning the one kind of capital that the Jews did seem to possess—technical skills, ingenuity, energy, desperation—to the production of miracles in scientific technology, that would contribute to the building of the new world."

If Weizmann today visited the Institute at Rehovoth that bears his name, would he be as impressed with the scientific work as all visitors are? Assuredly, yes.

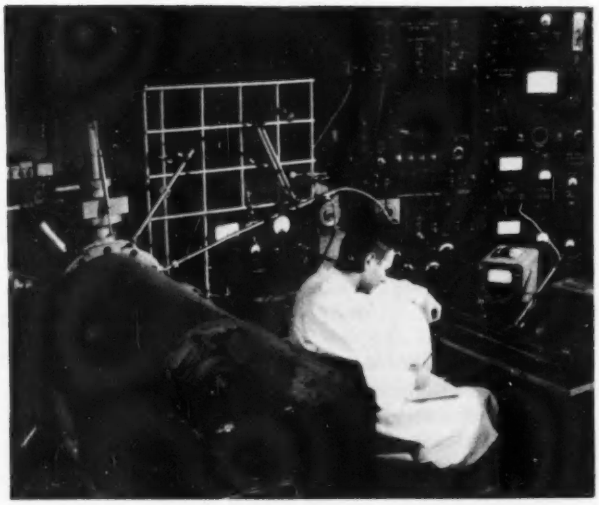
The first and overwhelming impression is one of beauty and of peace, so helpful for academic research. The two most recent buildings, the Wix Library and the Institute of Nuclear Physics, are, architecturally, delightful to behold as well as functional. The work or the Institute is divided into departments of applied mathematics, nuclear physics, electronics, optics, isotope research, polymer research, biophysics, organic chemistry, experimental biology, biochemistry and microbiology with sections on microanalysis and plant genetics. Apart from departmental libraries, a new central library was recently opened, and excellent mechanical and glassblowing workshops are at the service of research workers.

* See for example: Sir Isaiah Berlin, "Chaim Weizmann", Weidenfeld & Nicolson, 1958.

The origins of the Institute go back to 1934, to the Sieff Institute which was devoted to agricultural and pharmaceutical chemistry, bacteriology and the productive use of agricultural by-products. This Institute expanded, the Fritz Haber library was added to it in 1936, and today houses the department of organic chemistry. In 1944, to celebrate Weizmann's 70th birthday, his friends gave large sums of money for the expansion of the original Sieff Institute and ten years ago, in 1949, the new Weizmann Institute was formally opened. It has expanded ever since.

It is, of course, quite impossible to give here a full

Mr E. Blaugrund using a β-ray spectrometer measuring the short life-times of excited states of nuclei.



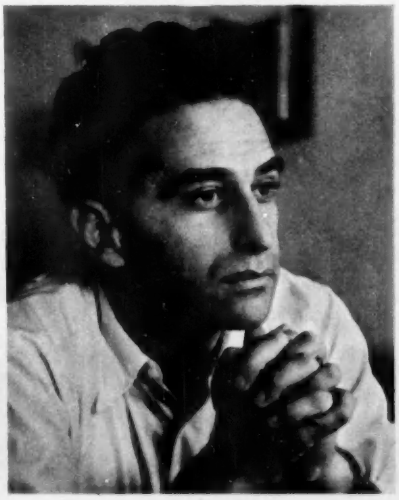
Institute of Nuclear Science.

account of the many current research projects at the Institute, but it is hoped that at least some of them will be discussed by their authors in future issues of DISCOVERY. Meanwhile, to mention a few, Sondheimer has made a brilliant synthesis of an entirely new class of organic chemical compounds which are the higher one-ring homologues of benzene with 18 and 24 carbon atoms. Hirshberg has worked for many years in the field of photo-chromism and this is now bearing practical fruit with the development of a photo-chemical computer memory. The Institute has its own electronic computer, WEISAC, which was built by its own staff; it is now used 24 hours a day, 7 days a week. Among the many different applications, it was employed by Pekeris in the evaluation of seismic data for a study of the internal structure of the earth. The field of polyelectrolytes is an important topic of research at the Institute and may prove perhaps of vital importance in the agricultural settlement of the Negev. In biology, Berenblum's work on the two-stage mechanism of cancer with the formation of a dormant tumour cell and a secondary promoting action is an entirely new concept. Equally important is Shelesnyak's study of the function of histamine during the implantation of the fertilised ovum, and this may well have practical results in relation to birth-control. Finally, the only isotope school in the Middle East is at the Institute; there scientists are currently working on "large scale" production of the O^{17} and O^{18} isotopes.

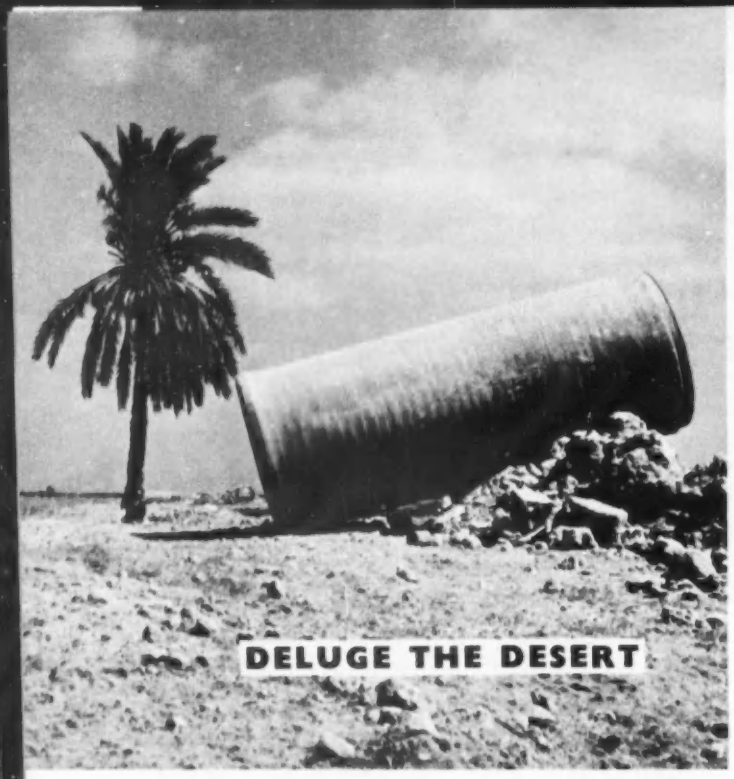
If in a recent *contretemps* with a Minister of the Israeli Government the pure research of the Weizmann Institute was called a luxury which a small country could not afford, one can only blame this on imperfect communication of science. Disraeli, when he asked Faraday about the possible use of electricity was told that one day he might be able to tax it; the Israeli Minister might well one day set off the "luxury" of the Weizmann Institute against the survival of his country or the health of mankind.

Dr Ephraim Katchalsky, Head of the Biophysics Department, Weizmann Institute of Science.

Prof. Amos de Shalet, Head of the Nuclear Physics Department, Weizmann Institute of Science.



Dr F. Sondheimer, Head of the Organic Chemistry Department, Weizmann Institute of Science.

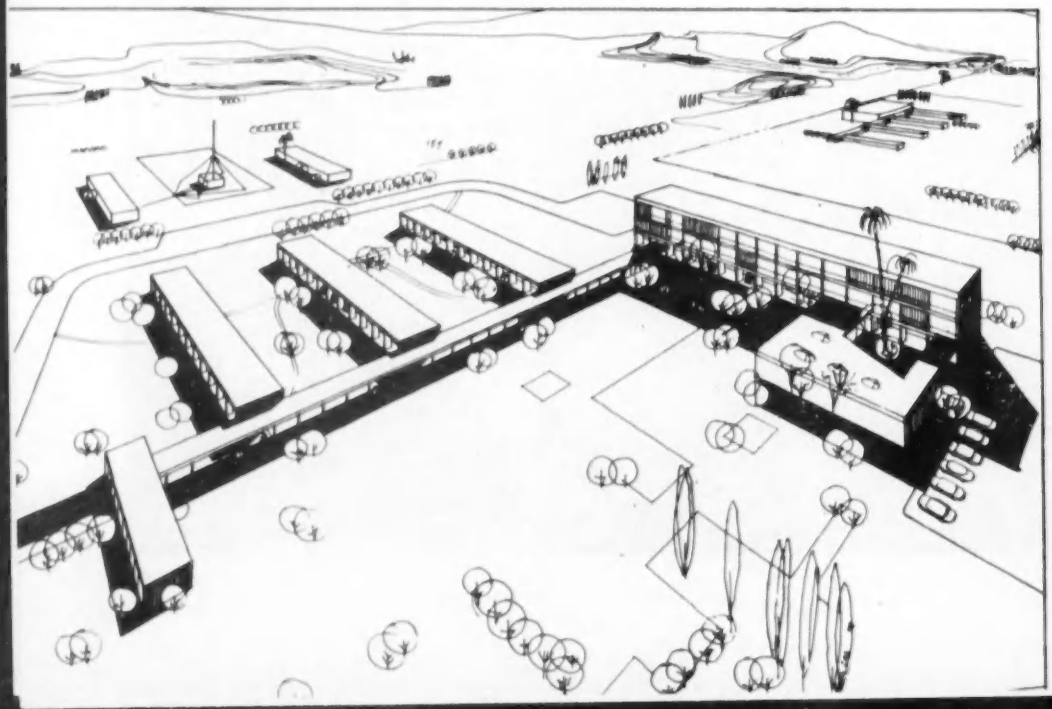


DELUGE THE DESERT

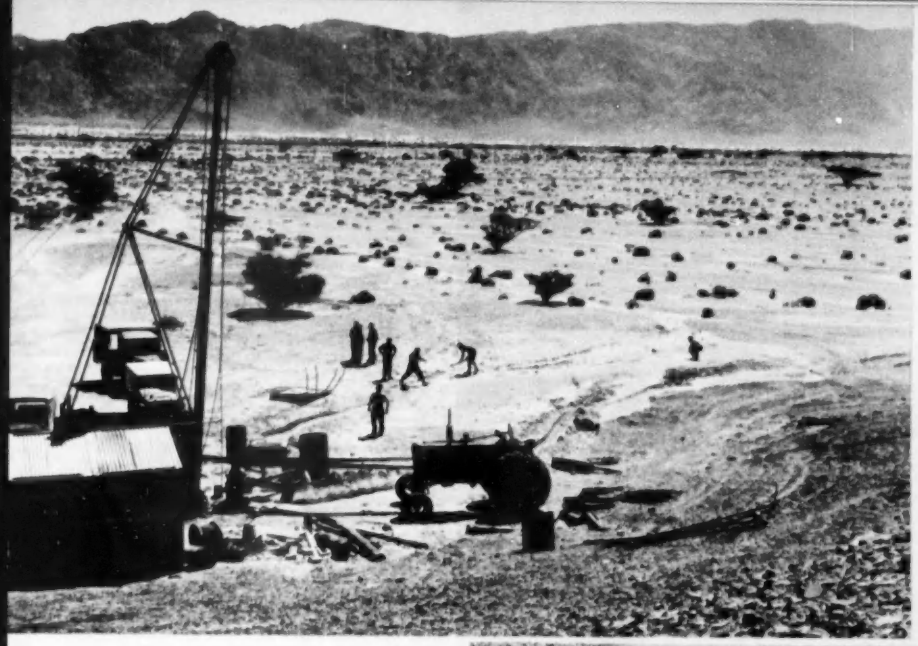
In Israel the national hobby is archaeology. It is therefore not surprising that the problem of desert research is attacked not only from a modern, scientific point of view, but also by an analysis of ancient agriculture dating from the Nabateans in the 2nd century B.C. to the Byzantine in the 8th century A.D. Michael Evenari, Professor of Botany at the Hebrew University of Jerusalem, who has made an extensive study of these cultures and their desert economy, is now proposing to test his views by the experiment of living in one of the ancient excavated settlements, Subeita. His results should prove of the greatest value, particularly to those scientists who are studying the desert at the Negev Institute for Arid Zone Research. This Institute, set up in 1957 by the National Research Council of Israel, has laid out an ambitious programme dealing with agriculture and biology, climatology, environmental physiology of the human, water desalting, solar energy utilisation, meteorology and the natural resources of the Dead Sea. A number of the research laboratories are already in full swing, a desert ecological garden has been planted with specimens of desert flora from many countries, and two pilot plants are engaged in the study of the economic production of Tabor's selective surfaces for solar energy use, and of the electric desalting of brackish water at a reasonable cost. The principle of the selective surface is the blackening, for the visible spectrum, of a highly polished metal surface, so that the surface has different properties at different wavelengths, like an optical filter; these surfaces have an absorption of 90% and an emissivity of about 10%.

Desalting of brackish water, of which there is a considerable amount in the Negev, can now be carried out by means of electro-dialysis at a cost that is no longer a burden for special industrial applications, although it is still too high for agriculture. It is the aim of the Negev station to do considerable research on the preparation of cheap, efficient and long-lasting plastic membranes in the dialysis units and Matz, who is in charge of this project, is hopeful that this can be achieved.

Irrigation has made vast strides during the last ten years in Israel and the percentage of irrigated area to total cultivated area has risen from 18% to 27%. As the Negev represents about 60% of the total area of Israel, it is understandable that plans are now being made to extend the irrigation schemes that have proved so successful in the northern areas also to the southern deserts. The ambitious Jordan–Negev system aims to bring water from Lake Tiberias to the Negev, a distance of about 200 km., through pipes 108 in. in diameter. However, this scheme is only partially completed. In the meantime four satellite schemes have been undertaken—including the drainage of the Hula Lake—and one of them alone, bringing water from the Yarkon river, near Tel Aviv, to the Negev, will pour 200 million cu. m. of water per year into the desert.



General development plan, Negev Institute for Arid Zone Research Station in Beersheba.



(*Left*) Constant drilling for water and seismic exploration of the desert are part of scientific research in Israel.

(*Above*) A 66-in. diameter pipe-line is being laid across Israel to bring water from the north to the desert area of the south. (*Left*) The reservoir at Qula from where water is distributed.

TEACH TECHNOLOGY

The new campus of Technion City at Mount Carmel, Haifa. Here on a forested area of some 300 acres, more than a dozen new buildings have been constructed and a student body of over 3000 is now being transferred to the new campus. In this picture the following buildings are shown: Building Research Station; Winston Churchill Auditorium; Aeronautical Engineering Building; Sanitary Engineering Laboratories; David T. Siegel Hydraulics Laboratory; Morris Mauerberger Soil Engineering Laboratories; Henry F. Fischback Electrical Engineering Building; Albert Einstein Institute of Physics.

Sixteen miles of Yarkon River, outside Tel Aviv, are reduced to a 225-ft. scale model constructed on the Mount Carmel campus of the Technion, Israel's Institute of Technology. Here scientists are conducting tests in an effort to prevent the periodic floods which in the rainy season transform the Yarkon, normally a small stream, into a menace to life and property. It is normal practice to preserve models of this kind for at least five years and at the Technion this will provide teaching facilities for the Civil Engineering Department.

Typical of an intelligent scientific approach to a national problem is the work of H. Heimann, Professor of Industrial Chemistry at the Haifa Technion. Convinced that the desalting of the brackish desert water is not necessarily the only way to produce crops, he has re-evaluated the problems of desert plants and their requirements. Maintaining that the term "plant nutrition" is anthropomorphic, he has investigated the subject of balanced ionic environment and particularly the question of sodium-potassium balance. It is hoped that further practical work at the Technion, and at the Arid Zone Research Station in Beersheba, will show that the addition of potassium salts to brackish water will allow the use of a greater sodium-ion concentration and thus materially reduce the costs of desert irrigation. That an industrial chemist should take up this question is only one more sign of the great vitality and originality of Israel's science, the spirit that pervades the whole of the University of Technology at Haifa.

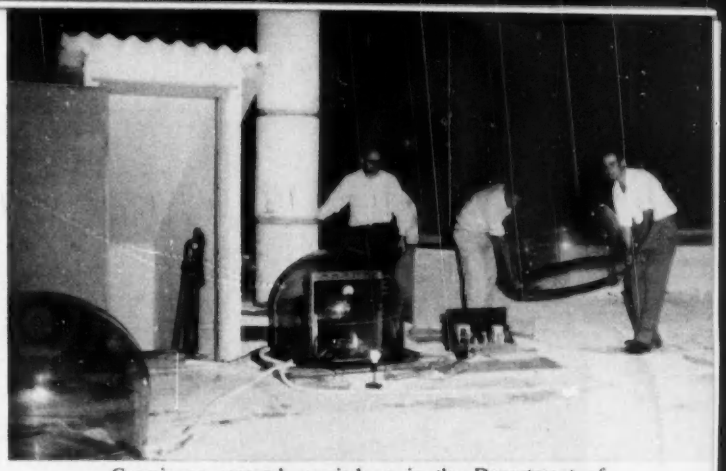
Situated in the most beautiful surroundings on Mount Carmel and overlooking the Bay of Haifa, the Technion is the oldest scientific institution in Israel. Construction of a technical college was begun in 1912 but only completed in 1923. The early days of the Technion have always been associated with the "battle of languages", for it was argued that Hebrew could not be used for the communication of science—German was then considered the only possible language. Today, all laboratories and lecture halls resound to the talk of Hebrew, the only common language to those who have come to Israel from well over seventy different countries and to the *sabras*,* the young men and women born in Israel. An Academy of the Hebrew Language is constantly at work to fit a biblical language for a scientific age, and scientists are fully satisfied with their new tool of communication. English is of course the second language taught at school and in the Army, and most scientific publications appear in British or American journals.

* *Sabra* is the Hebrew name for the fruit of a cactus, hard and brittle on the outside, but once the shell has been penetrated, extremely sweet to taste.

Today, the Technion offers bachelors, masters and doctors degrees in civil, mechanical, electrical, chemical, agricultural, aeronautical and mining engineering to its 3000 undergraduate and postgraduate students who can also study architecture, metallurgy and the pure sciences. The academic staff is composed of 450 full- and part-time teachers, including 23 full and 24 associate professors. The annual maintenance cost is about £1·4 million, of which the State of Israel contributes 40%, the remainder coming from fees, services to industry, and general contributions. The close link between the Technion and the Armed Forces of Israel was recently underlined by the Prime Minister when he stated that "The measure of a nation's security may be gauged in terms of its ability to keep abreast of its skills of technology". The President of the Technion is General Yaakov Dori, who was Chief of Staff of Israel's Army during her war of liberation in 1948.

There is certainly no appearance of falling behind in the skills of technology, on the contrary, the work at the Technion can compare most favourably with that of other similar places of learning and research. To take for example the Department of Hydrodynamics where small-scale models of rivers, dams, bridges, and pipes are studied. When this work is compared with that of SOGREAH at Grenoble (DISCOVERY, 1958, vol. 19, No. 5, p. 188) one naturally notices a difference in scale between the largest hydrodynamic research establishment in the world and a relatively young university department, but the research equipment, the details of model construction, and the intelligence of the staff and students are of the highest order. Outstanding also is Prof. M. Reiner's research work in the field of rheology, and his novel centripetal pump has already caused world-wide interest. More in the field of the pure sciences is the solar flare patrol unit set up by Dr N. Robinson which works during the first hours of sunlight, and thus augments the chain of stations round the earth which track changes on the sun.

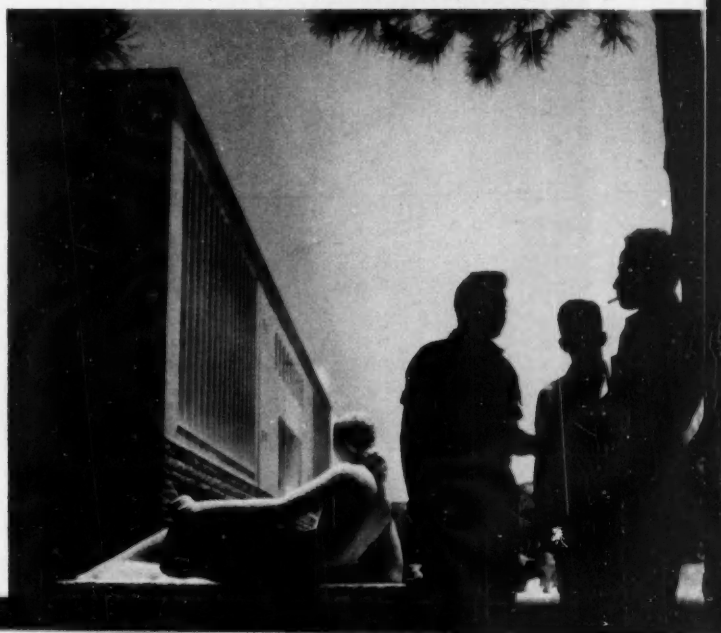
The efforts of the Technion Foundation Ltd, a consulting company doing research for Israel's young industry and for foreign customers are perhaps vital for the whole economic future of Israel. Between 1952, the year of its beginning, and 1957, its research staff has risen from 25 to 120 and the volume of research—in terms of fees received—from £20,000 to £110,000. These are still small sums when measured on an international scale, yet in the last year work has begun for Ghana and for Cyprus; both countries have commissioned work in the fields of soil research and road building. The Armed Forces of the U.S.A. have also begun to commission work from the Technion Foundation and one can foresee a time when the export of scientific research and technical "know-how" will play a large part in the economy of Israel. With the national awakening of many countries in Africa and Asia, and their desire to remain politically neutral, it seems not unlikely that they will turn to Israel for scientific help and technological advice. An indication of this trend is the work of Israeli doctors in Burma, where they are at present setting up a National Health Service. One must congratulate the director of the Foundation, Dipl.Ing. G. H. Majewski, on the work already accomplished and couple with it the hope that he can spread further the benefits of scientific research in his own country and abroad.



Cosmic-ray research carried on in the Department of Physics of the Technion.

Staff members of the Nuclear Engineering Laboratory ot the Technion, at work on the atomic reactor simulator. The Technion is now engaged in training nuclear engineers for maintenance and operation of Israel's first atomic reactor.

The Henry F. Fischback Electrical Engineering Building.



The Nature Reserve is now the only part of the Hula marshes which gives an impression of what the whole area looked like before draining.

All maps of Israel show three inland lakes, the Dead Sea in the south, farther north Lake Tiberias, and Lake Hula, the most northern, the highest and smallest of the three seas of the Jordan rift. But Lake Hula is no longer in existence since the drainage of the malaria-infested swamps was completed in 1957. These marshes used to display a rich tropical flora and fauna, particularly bird life, and the lake was used as a rest station by migrating birds. However, a portion of the valley has been left in its natural state to serve as a reservation with its beautiful water and pond lilies. The drainage was accomplished with modern floating ditch excavators that dug two deep canals from north to south. In addition a new bed was dug for the Jordan river, facilitating its flow to Lake Tiberias. The land uncovered was rich in peat and this is now used for agriculture; part of the watery area was left and now consists of fish-ponds where carp are reared as an important source of human food.

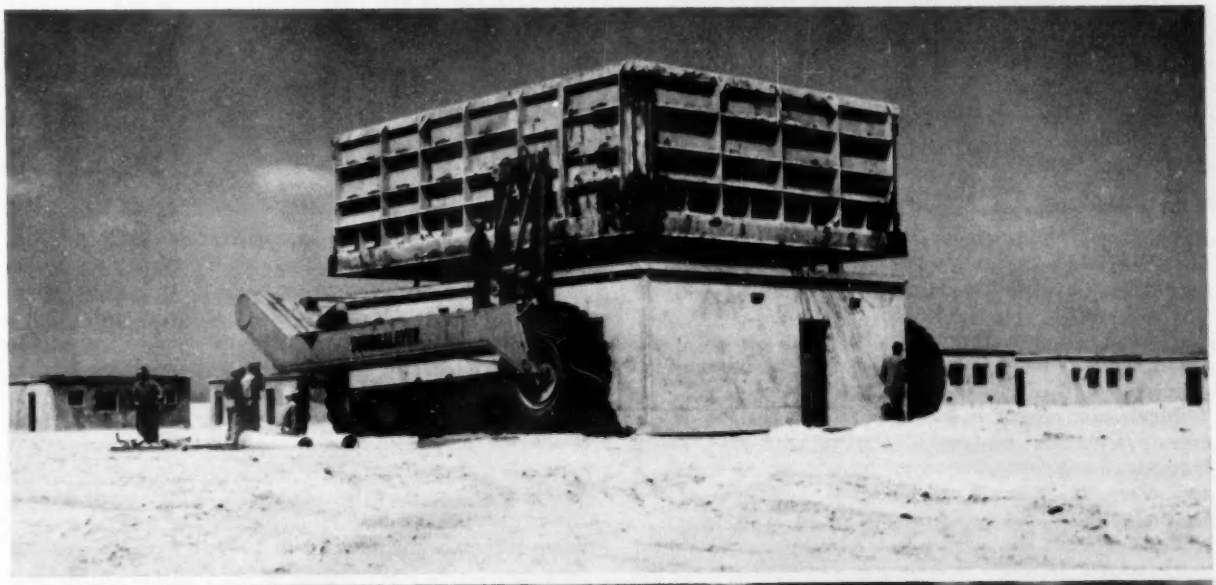
The story of the sudden death of all carp in a pond, caused by a micro-organism of the phytoflagellate type, and the subsequent research at the Zoology Department of the Hebrew University in Jerusalem to discover the cause and cure, has now become a classical tale of co-operation between pure and applied science. The cure is achieved by adding certain ammonium salts to the water, preventing the explosive growth of the micro-organism and at the same time fertilising the algae of the pond.

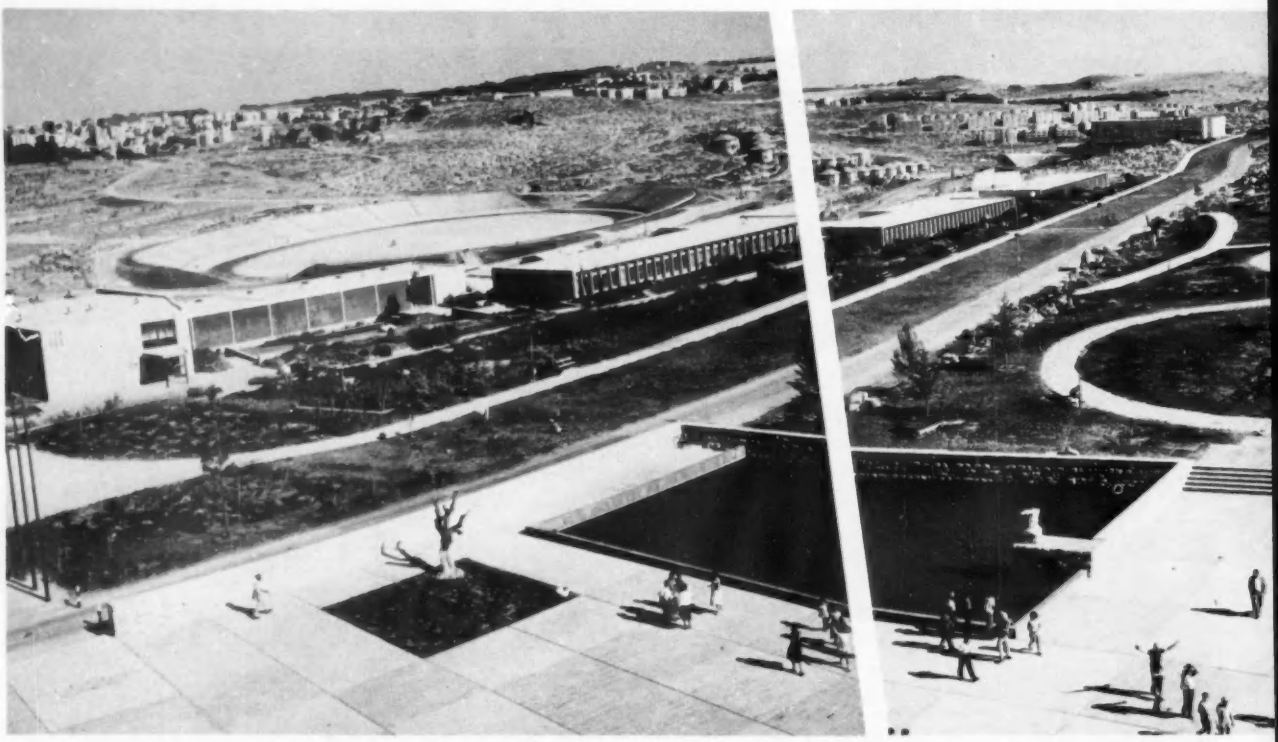
The River Jordan after draining the marshes.

Sowing the land recovered from the drained marshes.

HOUSE THE PEOPLE

Using Letourneau equipment for the construction of pre-cast concrete houses, the town of Kiriat Yam was built in a very short time in the desert. New immigrants from Europe live here.





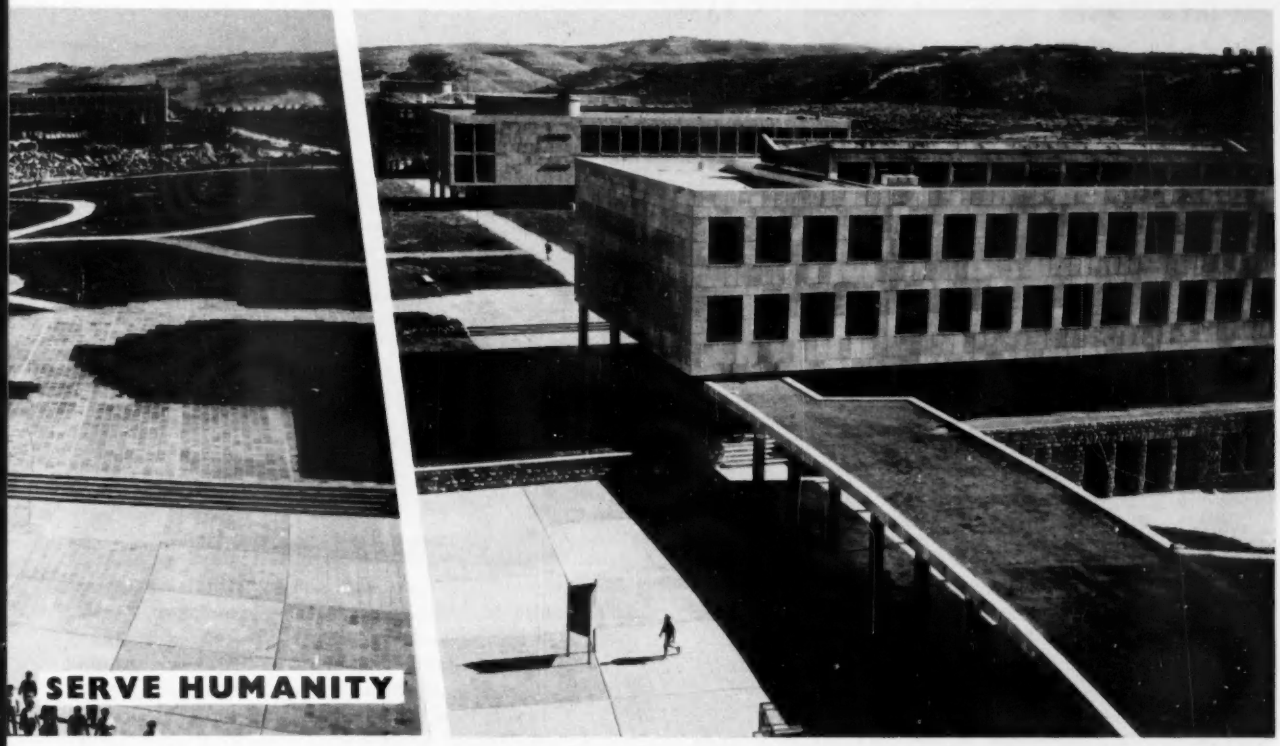
The Hebrew University in Jerusalem has a long, tragic history, equalled in modern times perhaps only by that of the University of Madrid. The idea of a Hebrew University was suggested as long ago as 1882, but it took many years of devoted labour by Weizmann, Paul Ehrlich, and others before the foundation stone could be laid in 1918 and the University formally opened by Lord Balfour in 1925. Its buildings were erected on Mount Scopus, one of the eastern hills of Jerusalem, and there it remained until 1948, having faculties of the humanities and the sciences, a school of agriculture, the National and University Library of almost 500,000 volumes, and the University Press.

When in 1948 the Arab-Israeli war began, the danger to the isolated Mount Scopus became immediately apparent and sniping and bomb-throwing made the passage to the University extremely dangerous. All students were soon drafted into the Army, but many academic staff members braved the journey to continue their research work. On April 13, 1948, a large convoy was attacked, and seventy-seven persons lost their lives, amongst them some eminent scholars and scientists. During the siege of Jerusalem, the University was often shelled, but on the whole the damage was not severe; however, in spite of a United Nations decision to make Mount Scopus a demilitarised area, it proved impossible for more than a few policemen and a skeleton staff of thirty-three civilians employed as watchmen to obtain access to the University. A fortnightly convoy has since 1948 assured food, water, and relief to them. When studies were resumed in 1949, temporary quarters were found, but the ever-increasing pressure of students made the situation more and more intolerable.

In 1954 a new site of 125 acres was dedicated at Givath

An observation post on Mount Scopus at the Hebrew University in 1948.

The Convoy to Mount Scopus. The fortnightly convoy to Mount Scopus, just before leaving Israel territory at Mandelbaum Gate in Jerusalem.



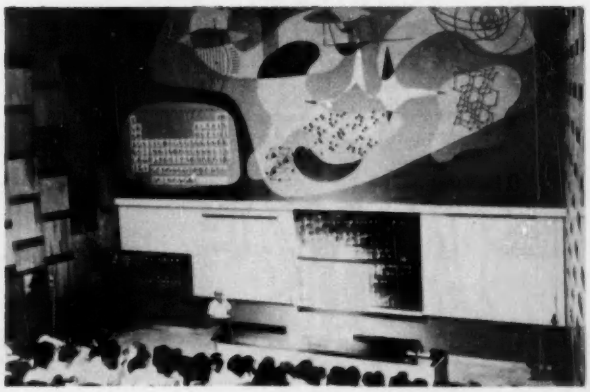
Ram, a hill on the western side of Jerusalem, and ever since new buildings have sprung up, each one more beautiful than the next. It is no wonder that new immigrants are shown over this campus to give them an idea of the future of their new country, and that they, as well as other visitors are deeply impressed. Today, again, faculties of the humanities and the sciences flourish, with departments of mathematics, physics, chemistry, botany, zoology, geology, meteorology, bacteriology, parasitology and physiology, and faculties of agriculture and medicine, law and social sciences. Well over 4000 students are at present enrolled and are taught by a staff of 750 teachers, including 48 full and 75 associated professors.

Next to the Army, the Hebrew University is probably the most powerful force in the country for welding the diverse constituents into a single nation. Hard work and an extremely serious attitude to life is the prevalent philosophy of the majority of students, who must complete their military service—2 years for girls and 2½ years for boys—before beginning their studies. One often hears what is almost a complaint from the teaching staff that the students are too serious and work too hard. Many of them are working their way through the University, boys doing building labour and girls landscape gardening. Folk dancing is a favourite pastime, sport is extremely popular, and chess, photography, and broadcasting have a large following.

Of the many research projects pursued at the University, only a few can be mentioned, some are well known internationally, others arise from local problems. For example, at the Einstein Institute of Theoretical Physics, the theory

Hebrew University student supplements his income by helping to build the campus.

A class in the new lecture hall of the building for Physical and Inorganic Chemistry. The wall display of the atomic table and symbols is not only useful in teaching, but also highly decorative.



Prof. S. Sambursky (*centre*), Head of the Section for the History and Philosophy of Science, in conference with Prof. Y. Bar-Hillel (*right*) and Dr J. Seide, the other two faculty members in charge of the new course. Prof. Sambursky is the holder of the Eleanor Roosevelt Chair in the History and Philosophy of Science.

and numerical calculations of atomic and nuclear energy levels is being investigated and through de Shalet, the Head of Weizmann Institute of Nuclear Physics, close links exist between the two research groups. In the Department of Chemistry, Prof. G. Stein has established a flourishing research school, concerned with chemical reaction kinetics and the effects of radiation on chemical and biological systems. In the Department of Botany, a close link is forged with the Arid Zone Research Station at Beersheba and a joint investigation on the germination, physiology, and ecology of desert plant seeds is in full swing. It was found, for example, that a treatment with 70% sulphuric acid for 30 minutes, followed by rapid washing, removed the growth-inhibiting substances of the shell in smilograss, *Oryzopis miliacea*.

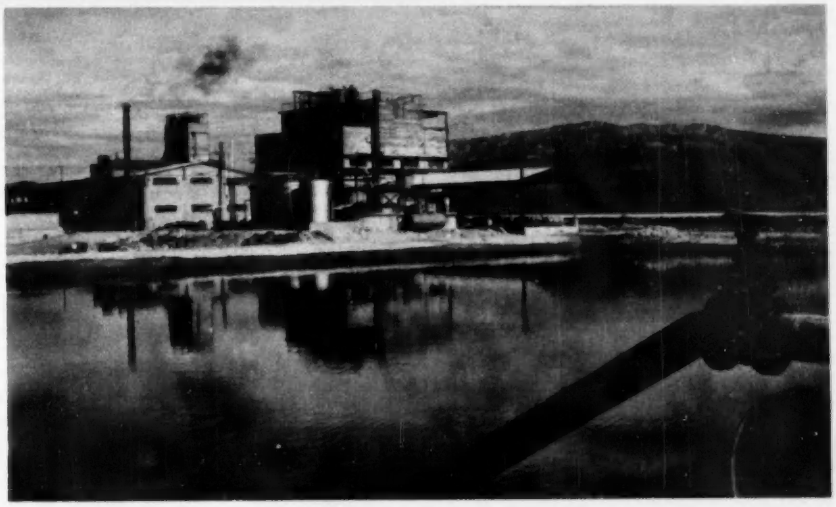
Prof. G. Hass, Head of the Department of Zoology, is a palaeontologist of great reputation and his investigation of fossil tadpoles and frogs found in Israel territory, have led to the comparison of these with similar living amphibians. The evolution of snakes, the swarming instincts of locusts, problems of fish physiology, and tissue culture experiments on the development and function of endocrine glands, are other research topics of the department. Outstanding in the faculty of medicine is the parasitological research work of Prof. S. Adler, F.R.S., and the cancer research work led by Prof. J. Gross. In this field biological mechanisms involving the transplantation of tumours from one species to another are studied. This work is based on the observation that such transfers are possible following the treatment of the prospective host species with material from the tumour donor species.

There can be little doubt that these and many other research fields are in the best academic tradition and that they, together with the high standard of teaching, combine to make the Hebrew University a true servant of the ideals embraced by all humanity.

Students of the Hebrew University, Jerusalem.

(*Left*) A view of the phosphate mines in the Negev.

(*Right*) The bromine plant by the Dead Sea.



(*Left*) The Malachite mineral found in King Solomon's Mines is concentrated at this installation, Timneh, deep in the Negev Peninsula.

Dr Sobel, a lecturer in the Department of Zoology at the Hebrew University, explaining to soldiers some features of marine and bird life.

The Israeli Defence Forces were created in 1948, in the midst of battle. They grew from the voluntary defence organisation, Hagana, and from the Jewish Brigade which fought with the Allied Armies during World War II. The Army consists essentially of a small corps of commissioned and non-commissioned regular officers, of the current national service contingents of men and women, and finally of the reserves.

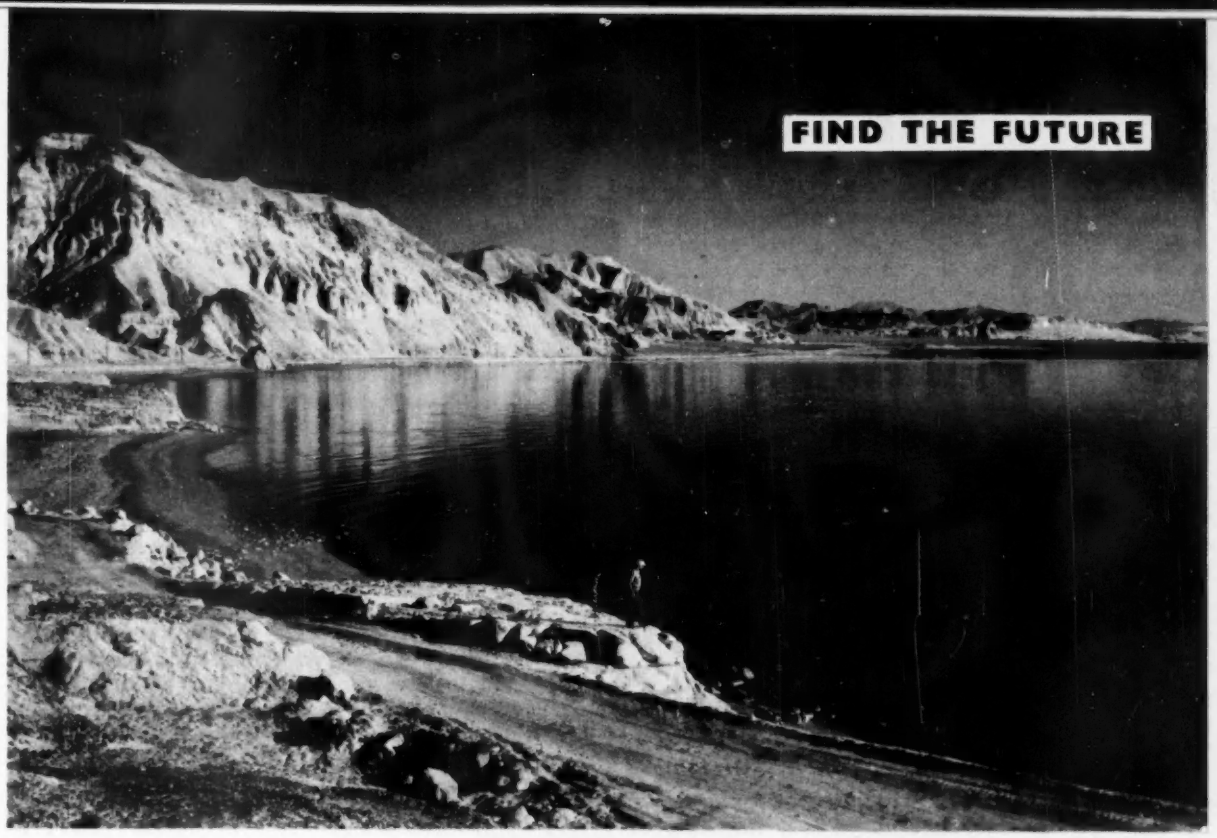
In some important respects the Israeli Army is unique. To begin with it serves as a school of Hebrew, assuring the utmost co-operation of its pupils by a series of modern and highly attractive texts. These are outstanding examples of the combined use of visual and textual materials and take as their major subjects science, geography and archaeology. It is sound psychology to teach a soldier to know his country and its history by heart, and constant lectures by officers, broadcasts from the Army's own radio station, and weekly journals issued to all serving and reserve soldiers ensure this knowledge; such a soldier who knows his country and understands the scientific principles underlying modern warfare is of course fully motivated and highly efficient. Textbooks are written for and published by the Army, and their extensive sale to the general public has borne the whole costs of publication. This alone is a great achievement and indicative of the national spirit of Israel.

In addition to these compulsory schemes of education one-third of all soldiers, both male and female, do additional study or teaching work in their free time. For example, three senior officers, including Colonel Y. Geva, Head of the Army's Manpower Division, obtained study leave and returned as students to the Hebrew University to obtain degrees in economics. With its large population of new immigrants, of whom some are illiterate and few have a command of Hebrew, almost the whole of adult education has fallen to the Army. Many of the women spend their free time teaching, after completing their day's work as clerks, storekeepers, telephonists, teleprinter operators, radio workers, mechanics or nurses.

The scientific textbooks used by the Army are prepared for them by members of the Technion, the Weizmann Institute, and the Hebrew University, who are also giving regular fortnightly lectures on their research specialities to officer courses. This extremely enlightened Army Education Policy is due to its Director, Colonel Ze-Ev, a poet, scholar, and philosopher, who is convinced that science must form an integral part of a modern person's education. As a teacher of his nation, and with the goodwill of Israel's scientists to help him, there is little doubt that the growing generation of *sabras* will not only be good soldiers, if the need arises, but more important still, will become members of a nation which has had a balanced, humane education, and one with an understanding of science.

Typical also of the Army's attitude towards science and learning was its treatment of the conquered Sinai Peninsula. It became the field station of Israel's archaeologists and biologists who were joined by the soldiers in collecting material which is still being worked on at present.

One-third of all serving soldiers, male and female, of the Israeli army study in the little spare time they have; a typical view of a class.



A scientist on the shore of the Gulf of Suez.

Israel may well be the promised land for many of its new immigrants, but unless a definite plan for its future is formulated now it may well celebrate its twentieth anniversary in 1968 as nothing more than an agricultural oasis in the Eastern Mediterranean. Admittedly the burden of the immediate problems has weighed down the balance in favour of immediate solutions, but this will never be enough.

Israel was founded by a scientist and a statesman, Chaim Weizmann (DISCOVERY, 1959, vol. 20, No. 1, p. 1), who has apparently remained alone, and whose unique example has neither been fully appreciated, nor has his approach to the future been perpetuated. He realised that intellectual capital can be created, and for this he planned ahead through a Hebrew University and an Institute for Pure Scientific Research. The results of his vision are already apparent and all who have seen the youth of Israel and who are qualified to judge the work of the higher institutes of learning are unanimous in their praise. But where are they going and what are they going to do in the future?

The use of this intelligent scientific manpower in industry has been suggested as the only path for Israel's future. One may well suggest that operational, economical, and historical research should be undertaken to learn from other small countries who are also deficient in sources of raw materials. Switzerland has solved her problems by the export of precision instruments, Norway by developing her shipping, and England by providing banking and insurance facilities for the world. Is there no lead here for Israel in the atomic age? Could the peaceful uses of atomic energy provide the answer, and is the isotope school at the Weizmann Institute already pointing the way? Or should Israel concentrate on becoming a pilot plant for applied science of underdeveloped countries? The Weizmann Press in Jerusalem is about to undertake the largest translation project ever done, a million-dollar scheme to make Russian scientific literature available to the English-reading world; is this the shape of things to come? Or perhaps the Technion Foundation is the precursor of a National Science Export Corporation, a giant Batelle Institute, which will preach the benefits of science throughout the world.

Weizmann was a first-class scientist and as such he knew that long-term planning was required to move from test-tube experiments through pilot-plant development to full-scale utilisation of any new idea. This systematic planning for the future is only apparent in the educational programme of the Army, and however good by itself, this is not enough. The allocation of priorities in the expenditure of money for scientific research is by itself not sufficient either, if there is no clear concept of the direction in which science can propel the country. Perhaps the formation of an Academy of Science, which is now being undertaken, may produce the helmsman to guide the ship. This lack of direction appears to be due to the fact that those best able to supply it are too busy with immediate problems, and find neither the time nor the opportunity for thinking about it or discussing it amongst themselves. The magnificent buildings in Israel are an act of faith for the future, and the first generation of qualified students coming from them are the best dividends that any country can have. Weizmann said: "I feel sure that science will bring to this land both peace and a renewal of its youth, creating here the springs of a new material and spiritual life." A new act of faith is needed and a long-term economic and scientific plan must be formulated now, if his words are really to come true.

THE BATTLE OF THE BOOKS

"Truth and Understanding are not such wares as to be monopolised and traded in by tickets and statutes and standards. We must not think to make a staple commodity of all knowledge in the land, to mark and licence it like our broadcloth and our wool packs".

JOHN MILTON: "Areopagitica".

Scientists, whose lifeblood depends on the fullest exchange of knowledge between peoples, are united in deploring contemporary barriers to a free flow of books; none the less, the gravity of the situation is rarely fully understood. The facts are startling. Ignoring major difficulties such as copyright and transport, we find that two-thirds of the countries of the world apply import licensing to books, while import duties are imposed in thirty lands. Admittedly, books imported into Britain are duty-free; even so, there are irksome restrictions, and it may, for instance, take weeks for even small consignments of scientific books from the United States to be cleared by Customs. Yet the removal of restrictions alone would not materially transform the scene. For the countries whose need of books is greatest could not, even if restrictions went, afford to increase their outlay significantly.

Though a free interchange is vital, there are other important considerations. The central issue is world hunger for books. A world output of around 5000 million books annually sounds vast, but it represents only two books per person, including school books. There is the complication of the inevitable existence of "haves" and "have-nots", so that three-quarters of all "titles" published are from ten countries only. Size of population, however, is far from being decisive, and small countries like the Netherlands, Switzerland, Austria, and Belgium lead the way as far as output per head of population is concerned. Scarcely less significant is the language factor, and, indeed, while 2500–3000 languages are used throughout the world, about nine-tenths of the world's literature is the production of six or seven languages. Translation does not obviate the problem: experience shows that countries which produce little literature tend also to be those which fail to publish translations, while English, which is itself a major source of translations, is equally a leading language into which books are translated. A decisive factor in this unique pattern is that of literacy. There is a high level of literacy among those speaking the major European languages other than Spanish and Portuguese, while in Asia, Africa, and even parts of South America, illiteracy is the rule, not the exception, and its abolition poses Herculean tasks.

It is against this grim background that our performance should be measured. In a limited sense, books are booming in Britain. About half as many new "titles" are being produced as before the war, but this generality conceals important qualifications. Probably about half of the books printed in Britain are sold overseas. This fact, satisfactory in itself, also means that in the matter of domestic book consumption Britain is lagging behind many Western nations. Outlay on books in State schools as opposed to private schools is noticeably low. Moreover, Britain's achievement in producing nearly twice as many "titles" as America is no unmixed blessing in that it unquestionably affects production costs. However, it is concerning book exports that the situation is most serious. Our growing export trade is not unnaturally focused towards English-speaking countries, though even this has its problems. New Zealand, for instance, whose total imports have risen 54% in a period compared with 18% in the case of books, has imposed a severe licensing scheme on book imports. But the harm of such restrictions is insignificant against Britain's inability to send sufficient books to many of the under-developed areas. For all the efforts made, our performance in Pakistan, India, Ceylon, and Burma must be contrasted with the success of American textbooks in university libraries overseas, notably in technical and scientific subjects. Furthermore, any modest satisfaction at the success of science publishing in Britain must be tempered by a recognition of even greater needs to be met if English is to prosper as the world's premier scientific language. Trade, Sir Stanley Unwin has said, follows the book, and this portent of future failure in the wider trade war is paralleled by our failure in the ideological war. Publications from Moscow and Peking, both in the vernacular and in English, flood into sensitive areas; indeed, a recent typical complaint was that in India, the only available English edition of Galsworthy was printed in Moscow!

How is our performance to be bettered? The Government, as we go to press, promise urgent consideration of this problem. Clearly there is need of an energetic attack on restrictions, some of which we have described. While this calls for international action, there is the special problem of countries which lack the currency to buy British books, and for whom a Government-backed book export scheme would be a blessing. Then there is the problem instanced of Indian students who are described as "so poor that they are buying grubby dog-eared lecture-notes in the bazaars because they cannot afford any books at all". Their need of a range of cheap publications poses to supplying countries like Britain the issue of subsidisation as well as of production techniques and structure in the publishing industry. Finally, there is the growing help which, it is to be hoped, will be forthcoming through Government Information Services and the British Council to libraries overseas. For may not one book contribute as much in ideological friendship as millions spent on propaganda?

Clearly the need is urgent. DISCOVERY is not so much concerned to map out the strategy of the Battle of the Books as to sound a rallying call. For neither nationally nor internationally can this problem be left to work itself out: it is a task for scientific appraisal and concerted action.

Important though the Battle of the Books is, one issue is of vital urgency for the whole of mankind—The Internationalisation of Space, and of Space Research. Scientific and political leaders of all nations must now create the International Space Research Institute, and they must formulate a Law of Space; COSPAR must become executive and not merely advisory. This issue is vital for the future of all mankind. *Caelum Commune!*

WRITING FOR SCIENCE

GEOFFREY PARR, M.I.E.E.
Technical Director, Chapman & Hall Ltd, Publishers

The good presentation of technical information is extremely difficult. A description of the principles underlying good writing and an insight into the difficulties may help the scientific writer

The Technical Writer. ...39

taken for granted, and it is only necessary to prevent his losing interest.

Depending on the technical standard of the publication, the style of writing may be more free in a technical article, and colloquialisms are not always out of place.

Instruction Leaflets and Books.

The writing of an instruction leaflet or book requires more than usual care if the author is also the designer of the equipment. He becomes so familiar with the details of its working that he omits to put down many features that will be required by the reader, and he tends to assume a greater degree of knowledge than the user of the equipment actually possesses.

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Instruction Leaflets and Manuals

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checked by an independent knowledgeable colleague, who should be able to operate the equipment successfully from the actual wording of the text. A common fault in instruction leaflets is

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THE TECHNICAL WRITER

Journal of the society when it is not possible to have them read, particularly if it is considered that a useful discussion would not be stimulated by the paper.

The Technical Article

The distinction between a technical paper and a technical article is not well-defined, and many ' reject ' technical papers are accepted for publication by a scientific periodical with only slight modification.

This modification is usually to make the text appeal to a wider class of reader, as it is obvious that the readers of any periodical may vary considerably in their knowledge of a technical subject and in their capacity for absorbing information.

Although it is not possible to be precise, the following differences between technical articles and technical papers or reports may be noted:

The report is usually intended for a specific class of reader, and one with which the author is familiar. An article is designed to have an appeal to a wider class which may have a range of intelligence and interests beyond the author's immediate circle.

In making a report it can often be assumed that the reader has a certain amount of pre-knowledge of the subject. This assumption is not necessarily true for readers of periodicals.

An article can and should introduce a background to the subject, and may be written in a more discursive style than a factual report.

The aim of an article is to attract the reader and to hold his attention. A report is often addressed to a reader whose interest can be taken for granted, and it is only necessary to prevent his losing interest.

Depending on the technical standard of the publication, the style of writing may be more free in a technical article, and colloquialisms are not always out of place.

Instruction Leaflets and Manuals

The writing of an instruction leaflet or manual requires more than usual care if the author is also the designer of the equipment. He becomes so familiar with the details of its working that he omits to put down many features that will be required by the reader, and he tends to assume a greater degree of knowledge than the user of the equipment actually possesses.

A handbook containing operating instructions should always be checked by an independent knowledgeable colleague, who should be able to operate the equipment successfully by following the

20

FIG. 1. The three stages of writing: the author's manuscript, the galley proof, and the finished page.

Unlike those who read science fiction or novels for relaxation, the reader of technical literature does so with a certain sense of duty. He has to keep up with the subject or find out whether his work has been anticipated, or even read what is being done in quite another branch of science from his own speciality. The writer of technical articles and books is thus assured of an audience when he finally gets into print, but it is an audience composed of busy people in search of information. The supplier of information has a duty as important as any designer of elaborate and expensive equipment: his product must be accurate, efficient, and give good value for money. The importance of the written word has increased to such an extent over the past fifty years that the technique of presenting technical information now ranks equally in importance with any other scientific accomplishment (DISCOVERY, 1959, vol. 20, No. 3, p. 110).

It has frequently been said that a good expositor is born and not made, or that one cannot be taught to write by following a set of rules. The same observations were once made about research workers, but nowadays training for research is a recognised part of a college post-graduate scheme. Not everyone can be trained to write, just as there are many who do not respond to research training, but the subject is of such importance that it should be an accepted

part of a scientific education. The pioneer work of Prof. R. O. Kapp in this field resulted in the appointment of a full-time Lecturer in the Presentation of Technical Information at University College, London, and it is to be hoped that this example will be followed at other universities and colleges. More recently, the City and Guilds of London Institute has published a syllabus of a course in technical authorship which is intended to take four years, ending in a qualifying examination.

There are, however, many scientific workers who have left college and who certainly cannot spend four years studying the technique of technical writing, and it is to those that these remarks are principally addressed. Is it possible to cultivate the art of technical expression or, having essayed it, to improve one's technique? The answer is almost certainly "yes" although no definite rules can be given. Perhaps the best approach is to revise one's attitude of mind and to cultivate more closely that of the reader.

THE READER

The most important person to be considered in the writing of any technical matter is the reader. Too often the writer undertakes his work egotistically with supreme disregard for the person on whom he depends for his reputation, advancement, or even monetary reward.

As Prof. Kapp once remarked: "We spend time and money in making it easy for engineers to read instruments quickly and accurately, but a writer takes very little trouble to help the reader to obtain information with the same ease."

There are several ways in which a reader can be consciously or unconsciously irritated. Most of them are in the omission of small details or in the commission of small faults which are trivial in themselves but cumulate to produce a bad impression. The principal causes of "reader irritation" are:

Using long, involved sentences, often with inadequate or wrong punctuation; taking for granted that the reader knows all about the subject, or knows nothing about it; saying "obviously", when the statement is not obvious; omitting steps in an argument, or slurring over parts of the argument that are not clear to the writer himself; making inconsistent statements; making use of woolly phrases or bad grammar.

The experienced writer, on reading through this list, may say, "Of course, but *I* don't do any of those things." Is that so? Here is a sentence from a descriptive booklet on tape recording, published recently:

> The tape feeler is to determine how much tape has been put on or wound off the right-hand spool, and is indicated on the graduated arc on the plastic top cover.

To say that the reader will "know what is meant" is begging the question; he may think that the writer's ability to design a tape recorder is on a level with his ability to express himself grammatically.

It is not even necessary to offend the reader by being ungrammatical. Many sentences are grammatically correct but still irritate by their length or by their involved construction. It should never be necessary to read a sentence twice in order to take in its meaning.

Examples of reader irritation can be multiplied almost

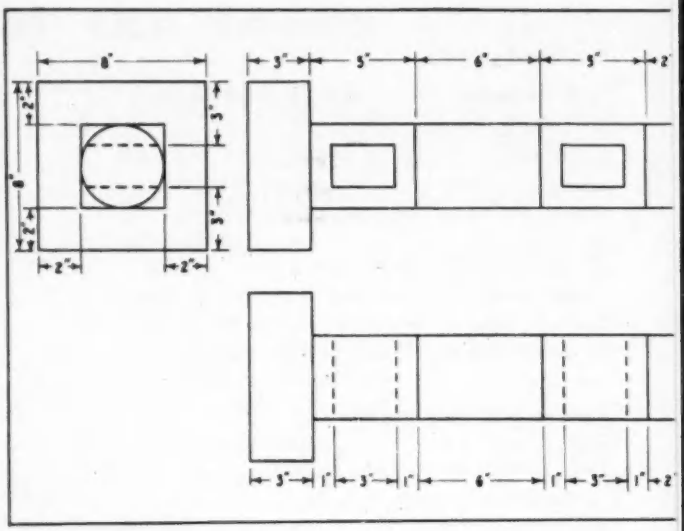


FIG. 2.

indefinitely, and the method of avoiding them can be summed up in the phrase "always put yourself in the place of the reader". It is a curious fact that an author is frequently aware of annoying mannerisms in reading another's work but will blithely permit similar mannerisms in writing his own text.

AWARENESS

This comment leads to the next attitude of mind that a conscientious writer tries to cultivate: that of *awareness*. The writer must be continually aware of what he is writing, what he has just written, and what he is going to write. No one who cultivates this approach to writing will repeat himself either in ideas or in sentences. Here is a simple example of lack of awareness in writing a paragraph:

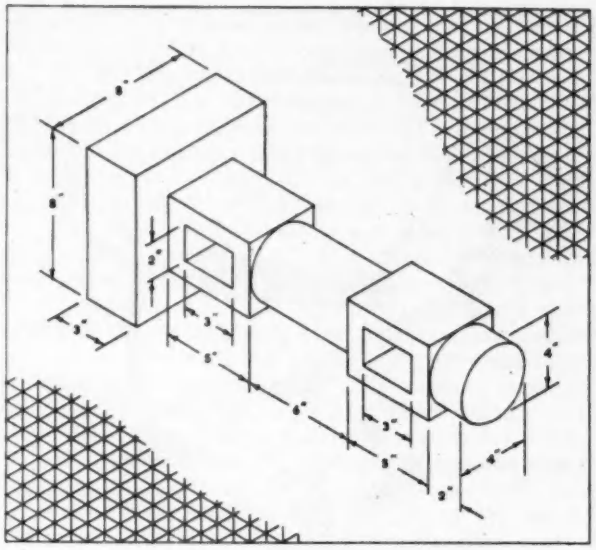
> Symmetrical varistors have application to protective purposes such as lightning protection, such as thyrite, and to acoustic shock prevention such as in telephone circuits.

Allied with unnecessary repetition of words is the repetition of particular forms of grammatical construction that appeal to the writer's sense of style. Some of these forms are bad habits that should not have been acquired: for example, Dr J. R. Baker* condemns the excessive use of adjectival nouns (for example, "adenosine triphosphate activated actomyosin contraction") as in German writing. He ascribes this construction to the influence of English-speaking German scientists on the literature, and writers who imitate it probably do so to give an impression of terseness.

GRAMMATICAL FAULTS

Most writers claim to have a working knowledge of grammar and composition, though it is probable that this knowledge was acquired at school and they have had little

* *Nature*, 1955, November 5, p. 851.



opportunity to add to it after leaving. A number of minor grammatical faults can nearly always be found in carelessly prepared manuscripts, and any editor will confirm that a flawless manuscript is so rare as to call for comment and, it is hoped, a compliment to the author. Even with experienced writers it is possible to pick out grammatical slips, and some of these are so common that it is questionable whether they ought not to be accepted nowadays as part of the changing language. The unrelated participle is still rightly condemned by purists ("After boiling, the flask was removed . . .") but how often do we read, "Referring to Figure 3, it will be seen that . . ."?

We know that words are continually being modified in meaning, if not being debased, and this change is part of the life of the English language. It is only a short time since the word "intercourse" had a very different meaning, and a more respectable one, from that which is now assigned to it. If words can change, cannot the rules of grammar fall into disuse? The constructions that are at present considered bad may in a few decades be accepted as convenient short cuts in expression, and even the split infinitive may acquire a permanent respectability.

VOGUE-WORDS

Fowler, in "Modern English Usage",* has an apt comment on vogue-words, which cannot be bettered:

> Every now and then a word emerges from obscurity or even from nothingness . . . into sudden popularity. . . . Ready acceptance of vogue-words seems to some people the sign of an alert mind; to others it stands for the herd instinct and lack of individuality.

This comment was written before the advent of the technical vogue-word, but it may be taken to apply to all those terms that are taken up by writers and worked to death. Once a word has become fashionable there is a tendency to use it regardless of whether it is apposite or not. The word "tool", for example, is now applied to a process, technique, method of procedure, and even an abstract science. The writer who said that

> X-ray crystallography, the chief tool of structural analysis, is curiously amorphous . . .

showed a complete disregard for the niceties of the English language. Let the skilled technical writer show his refusal to follow the "herd instinct" by avoiding the easy, popular word and taking time to choose one which conveys his exact meaning. Boswell has laid down once and for all in memorable (albeit slightly pompous) prose the guiding principle for all writers:

> "I believe with justice that there is for every thought a certain nice adaptation of words which none other could equal, and which, when a man has been so fortunate to hit, he has attained in that particular case the perfection of language."

ILLUSTRATIONS

The written word, though of major importance, is only part of the whole presentation of technical information. Many descriptions become unintelligible unless they are accompanied by an illustration which has been specially designed to show the points mentioned, and the drawings or photographs should form an integral part of the text matter.

Unfortunately the reproduction of photographs is expensive, whatever the process used; in some methods of reproduction the finished result does not do justice to the original. It is worth considering, therefore, whether a line drawing cannot be made to serve the purpose of a photographic print, and some editors will certainly look favourably on an article which does not demand costly photographs to illustrate it.

In preparing illustrations for an article intended for trained engineers the writer can assume that they are accustomed to interpreting engineering drawings. A great deal of technical literature, however, is read by men trained in other branches of science who need something more than an orthodox projection to understand a drawing, particularly if it shows the construction of apparatus. For this reason it is preferable to show the illustrations in a more pictorial form, using perspective and shading to give the reader a clearer impression. The preparation of good perspective drawings is an art which is not necessarily learnt by an engineer-draughtsman, and he may prefer to make use of one of the orthodox methods of showing two-dimensional views, as illustrated in Fig. 2. The conventional elevation is shown on the left, and it will be agreed that the interpretation is difficult, even to a trained engineer. The drawing on the right has been done on isometric paper in which the background is composed of isosceles triangles, and the result is a true dimensioned drawing in which the relative components stand out as though in perspective. Drawings of this type are well within the capabilities of an engineering draughtsman and greatly improve the presentation of the subject.

Mention must be made of two valuable aids to drawing which are not so widely known as they deserve to be. These

* Oxford University Press.

are the so-called "tints", which are not colours but mechanically accurate sheets of printed lines or dots on translucent material with an adhesive backing. They can be used for shading or indicating sections, and save the tedium of drawing ruled lines across a part of the illustration (Fig. 3).

Two types are available in this country—the "Zipatone", marketed by Hunter Penrose & Co. of Farringdon Road, and the "Plastitone", sold by West & Partners of Broadway, Westminster. In the use of the tint, the sheet is pressed down on the area to be covered and rubbed lightly to make it adhere to the paper. The surplus is then trimmed off with a sharp knife. A wide variety of patterns is available, and

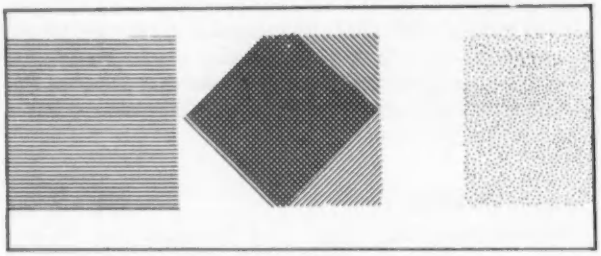


FIG. 3.

the saving in trouble is well worth the cost of the sheet. The second drawing aid is a sheet of letters and figures printed on transparent material suitable for applying to drawings. These give the effect of printed letters, and are applied in the same way as the tints. They are sold by Hunter Penrose under the name "Artype", and include in the series many forms and sizes of lettering. A word of caution: before applying tints or lettering to drawings intended for publication in a journal, consult the editor. The particular style of lettering may not suit his requirements.

DRAWING FOR REPRODUCTION

It is a golden rule that drawings should never be made the same size as that intended for the finished article. The photographic and printing processes inevitably coarsen the line structure in the drawing and it suffers in reproduction. A convenient proportion of original to reproduction is 2 : 1, although 3 or 4 to 1 is usually acceptable. It is frequently overlooked that the photographic reduction also thins down the lines of a drawing, so that they should be drawn at least twice the desired thickness of the finished line. Graphs intended for reproduction can always be drawn on paper with grey or blue background lines, which will disappear in the finished printing. The worst type of background is one with orange or red lines, which are difficult to separate out in the photographic process. Curves should not be drawn on millimetric paper unless great accuracy in reading is required: the squares tend to fill with ink in the final printing, and if the graph is reduced in size it is practically impossible to produce a good result. It is questionable whether the use of millimetric paper is ever justified in a drawing intended for reproduction, as an apparent increase in accuracy of reading is offset by the difficulty in interpolating by eye. In this, as in every case, the convenience of the reader is paramount.

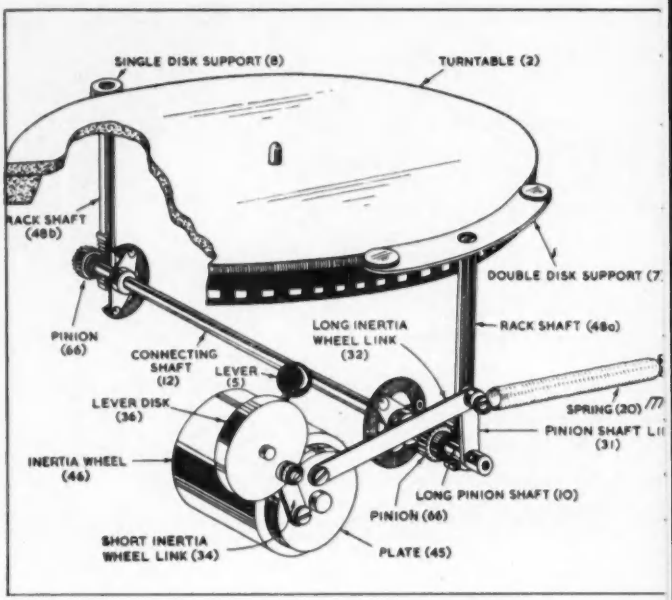


FIG. 4. Sample of pictorial drawing.

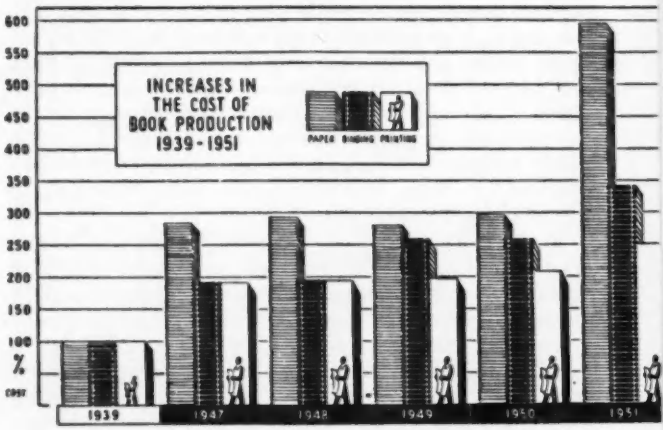


FIG. 5. Sample of pictorial representation.

FINISHING OFF

It is generally recommended that technical articles should be put into cold storage before submitting them for publication. This gives the writer a chance to view his work in perspective and also to pick up any flaws that he has overlooked in the process of finishing it off. Unfortunately the urgency of present-day publishing does not allow him much time for reflection and revision: delay in making his work known may result in someone getting in ahead, particularly if the subject is a "live" one. The only alternative to a soak-test for technical articles is to draw up a form of questionnaire and try to answer it as conscientiously as possible.

The spirit of self-criticism is the most valuable asset that a writer can cultivate, but it is difficult to acquire and it is worth using any means of checking the finished product

while experience is being gained. Some questions that the writer may ask himself at the conclusion of his writing are:

Is the style consistent throughout the text and suited to the reader? Can any of the statements be misinterpreted? Are the main ideas given proper emphasis? Is the treatment balanced? Are there any unfamiliar terms left unexplained? Is the explanation snobbish? Are the illustrations clear and helpful to the text? Is the tone of the article moderate and objective? Are the symbols and abbreviations consistent with standard practice? Have all acknowledgements to outside sources been made? Is any copyright involved?

It should be noted that in submitting an article for publication in this or any other journal the illustrations should never be included in the text matter. It is always preferable to collate them separately with a list of captions (legends) and check that each illustration is referred to in the text by its appropriate number. Mathematical formulae should be printed carefully by hand (unless the typewriter has a full range of mathematical symbols—a rare asset) and particular care should be taken in forming the Greek characters (DISCOVERY, 1958, vol. 19, No. 3, p. 104)

able, and an editor would be within his rights in objecting to a number of trivial corrections which should have been made in the original manuscript.

It is not often realised how much alteration is required to a proof when the author decides to insert an extra word of explanation or clarification. Fig. 6, which is reproduced from an actual proof, shows how the insertion of a single word required the alteration and resetting of ten lines of text. Considered in terms of hard cash, this afterthought cost 9*s*. If such an alternative is essential, the least that an author can do is to try and make the disturbance of type as slight as possible; this can usually be done by modifying the wording of adjacent phrases to accommodate the extra letters. Besides being a good exercise in ingenuity, this re-sorting will earn the appreciation of both editor and printer.

It is worth noting that the better the style of the author, the more difficult it becomes to modify his text to insert or take out words.

Once the galley proofs have been passed by an author, further modifications become almost impossible. The text

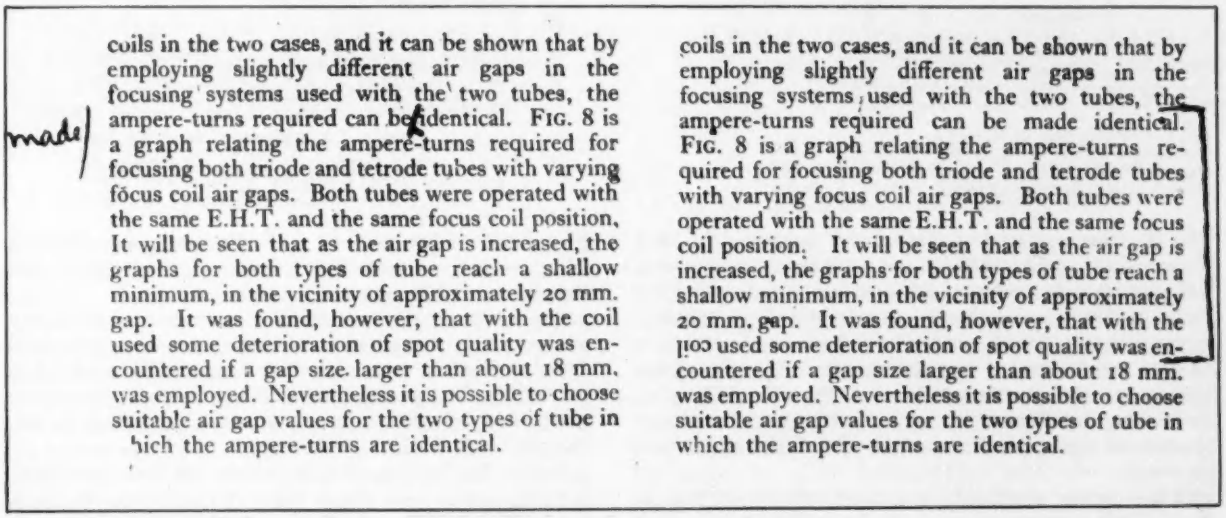

made
coils in the two cases, and it can be shown that by employing slightly different air gaps in the focusing systems used with the two tubes, the ampere-turns required can be identical. FIG. 8 is a graph relating the ampere-turns required for focusing both triode and tetrode tubes with varying focus coil air gaps. Both tubes were operated with the same E.H.T. and the same focus coil position. It will be seen that as the air gap is increased, the graphs for both types of tube reach a shallow minimum, in the vicinity of approximately 20 mm. gap. It was found, however, that with the coil used some deterioration of spot quality was encountered if a gap size larger than about 18 mm. was employed. Nevertheless it is possible to choose suitable air gap values for the two types of tube in hich the ampere-turns are identical.
coils in the two cases, and it can be shown that by employing slightly different air gaps in the focusing systems used with the two tubes, the ampere-turns required can be made identical. FIG. 8 is a graph relating the ampere-turns required for focusing both triode and tetrode tubes with varying focus coil air gaps. Both tubes were operated with the same E.H.T. and the same focus coil position. It will be seen that as the air gap is increased, the graphs for both types of tube reach a shallow minimum, in the vicinity of approximately 20 mm. gap. It was found, however, that with the coil used some deterioration of spot quality was encountered if a gap size larger than about 18 mm. was employed. Nevertheless it is possible to choose suitable air gap values for the two types of tube in which the ampere-turns are identical.

FIG. 6. Part of a galley proof showing the trouble and expense involved in adding a single word to the made-up column. To pack this word in, the type has had to be redistributed over ten lines. Note also the error in the last adjusted line, which might not have otherwise occurred.

CHECKING PROOFS

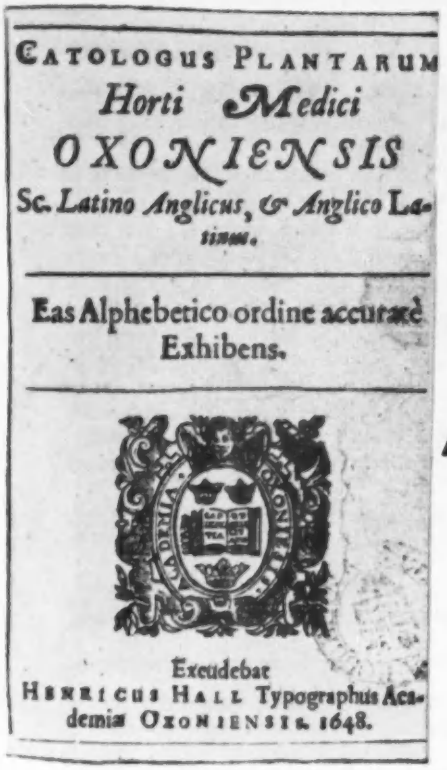
Between the acceptance of his manuscript and the arrival of the printer's proofs (galley proofs) every writer has second thoughts. It may be that new information has become available, which of course must be added to the article, but more often it happens that a better method of expression is thought of, or an ambiguity is noticed. No matter how carefully the typescript is checked, it always looks different in cold type.

It is in proof-correcting that the writer must exercise self-restraint. Ideally, if the finished manuscript were perfect, there would be no need for any alterations by the author other than those required by later information. In practice, an author too often makes the galley proof a basis on which to attempt to rewrite the article. This is inexcusis assembled with the illustrations into page form, and thenceforward any last-minute corrections may involve pulling the whole assembly to pieces and remaking the text matter. As most periodicals work to a rigid time schedule, both editor and printer have reached the limit of the concessions they are prepared to make towards accuracy and presentation.

One of the first duties of a conscientious writer is to make himself familiar with the printing and reproduction processes involved in presenting his material. He would then undertake the work of writing with a more sympathetic approach to the people who produce it. The most successful technical literature, whether book, article, or leaflet, is the result of close collaboration between the author and the producer.

HISTORIC SCIENTIFIC BOOKS AT OXFORD

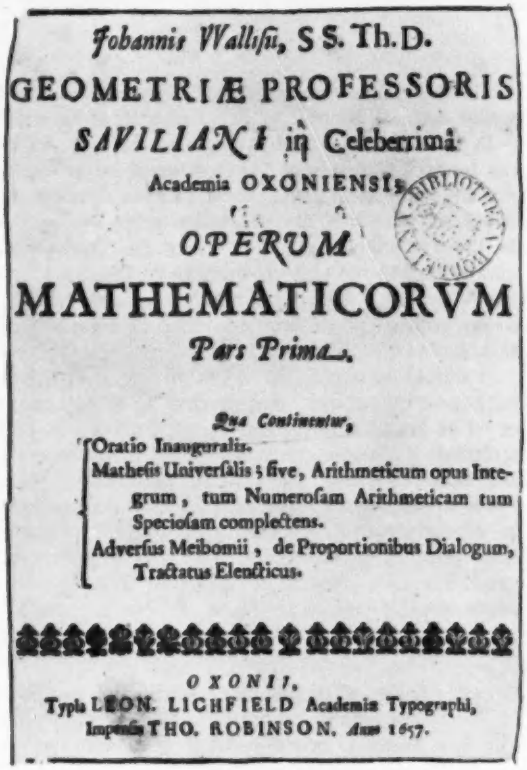
A. M. WOOD
Clarendon Press, Oxford


CATOLOGUS PLANTARUM
Horti Medici
OXONIENSIS
Sc. *Latino Anglicus, & Anglico Latinus.*

Eas Alphebetico ordine accuratè Exhibens.

Excudebat
HENRICUS HALL Typographus Academiæ OXONIENSIS. 1648.

FIG. 1. The title-page of Bobart's "Catalogue of the Plants in the Oxford Physick Garden". Note the misspelling in the first word.


Johannis Wallisii, S.S. Th.D.
GEOMETRIÆ PROFESSORIS
SAVILIANI in Celeberrima
Academia OXONIENSI,
OPERUM
MATHEMATICORUM
Pars Prima.

Quæ Continentur,
Oratio Inauguralis.
Matheſis Univerſalis; ſive, Arithmeticum opus Integrum, tum Numeroſam Arithmeticam tum Specioſam complectens.
Adverſus Meibomii, de Proportionibus Dialogum, Tractatus Elencticus.

OXONII,
Typis LEON. LICHFIELD Academiæ Typographi,
Impenſis THO. ROBINSON. *Anno* 1657.

FIG. 2. The title-page of the first volume of Wallis's "Mathematical Works". He was the first mathematician to replace xx by x^2.

The first book printed in Oxford was published in 1478. Between that year and 1486 it had some fourteen successors but after that the press at Oxford was silent until 1517. From 1517–19 there was a brief burst of activity, followed by a gap until 1585. From then on there has been a continuous production of learned works on behalf of the University, though the decree of the Star Chamber, authorising the University to have one press with one printer and one apprentice was not issued until the following year.

It is tempting to consider the two works by Sir Francis Bacon, "The Advancement of Learning, Divine and Humane" (1633) and "Of the Advancement and Proficience of Learning or the Partitions of Sciences" (1640), as the first science books published in Oxford, but while they were widely read at the time their scientific content was meagre. From an 18th-century reference it may be inferred that an edition of Euclid was published in 1644, but, if this was so, no copy has survived. However, despite the disruptions of the Civil War, Bobart's "Catalogue of the Plants in the Oxford Physick Garden" (alias the Botanic Garden at Oxford, founded in 1621 and thus the oldest in England) appeared in 1648.

In 1651 the first work of the mathematician W. Oughtred, bearing an Oxford imprint, was published; the last was issued in 1693, thirty-three years after his death.

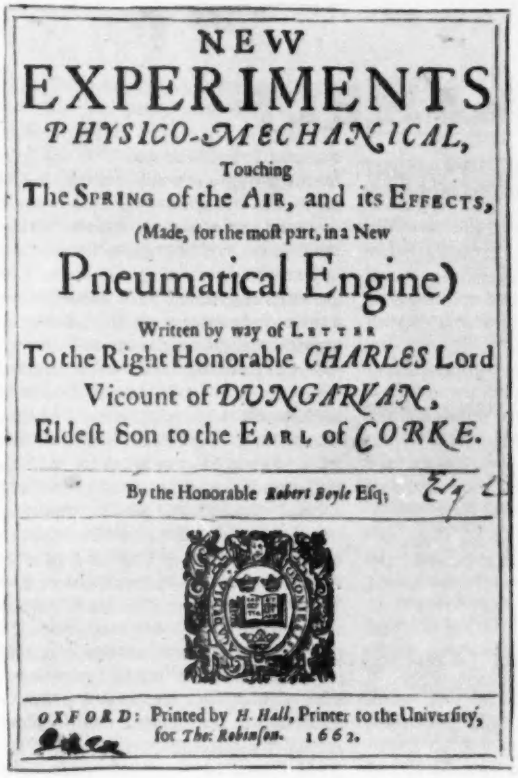
There is no doubt that interest in science was growing in Oxford during this period; the leading figures being Robert Boyle and John Wallis, and those others such as Wilkins, Bathurst, Ward, and Petty, who were members of the "Invisible College", the precursor of the Royal Society. Slowly lists of publications of the University Press show a swing away from alchemy to more exact formulations of the problems of physics and chemistry.

The early publications of Wallis are concerned with a dispute on geometry that he carried on for some years with Thomas Hobbes, and it was not until 1657 that the first part of his "Mathematical Works" appeared. The complete works and miscellaneous papers were published by the Press in 1693.

Robert Boyle's experiments on the air were published in 1660 under the title, "New Experiments Physico-Mechanical Touching the Spring of the Air and its Effects". This was reprinted two years later. His "Hydrostatical Paradoxes" appeared in 1666, a sequel to the "Spring of the Air", in 1669, collected tracts containing new experiments on "Flame and Air and Explosions" in 1672, a collection of tracts on "The Saltness of the Sea" and hygroscopical matters in 1674, his notes on the "Mechanical Origin or Production of Electricity" in 1675, and in 1680 his "Sceptical Chymist". His publications thus cover one of the most significant periods in the development of the University Press itself.

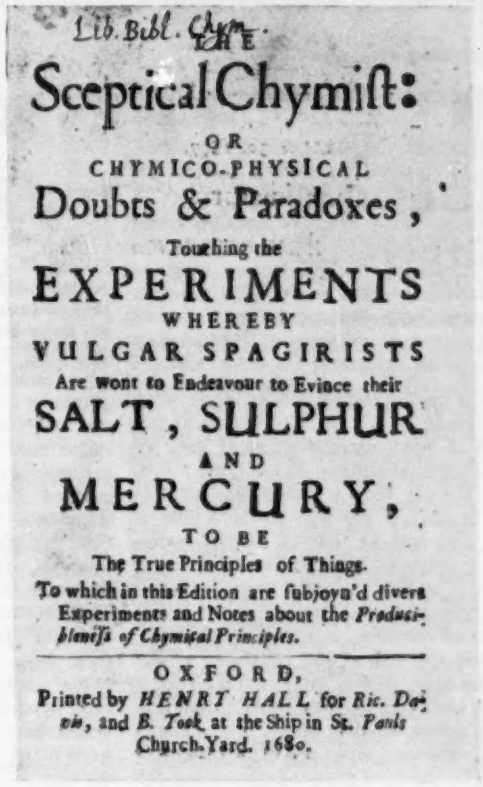
The first Delegates of the Press were nominated in 1633, but no record of their deliberations before 1668 has survived.

In the following year the Sheldonian Theatre was opened. The primary purpose of this building was to provide a place for the ceremonial acts of the University, but its donor had given instructions that the cellar (and the rest of the building when not required for this) were for the use of the University Press. The Delegates of the Press at that



NEW
EXPERIMENTS
PHYSICO-MECHANICAL,
Touching
The SPRING of the AIR, and its EFFECTS,
(Made, for the most part, in a New
Pneumatical Engine)
Written by way of LETTER
To the Right Honorable CHARLES Lord
Vicount of DUNGARVAN,
Eldest Son to the EARL of CORKE.
By the Honorable Robert Boyle Esq;
OXFORD: Printed by H. Hall, Printer to the University,
for Tho: Robinson. 1662.

FIG. 3. The title-page of Boyle's "Spring of the Air". Already even at this date publication of scientific work in Latin is beginning to give way to publication in English.



Lib. Bibl. Chym.
THE
Sceptical Chymist:
OR
CHYMICO-PHYSICAL
Doubts & Paradoxes,
Touching the
EXPERIMENTS
WHEREBY
VULGAR SPAGIRISTS
Are wont to Endeavour to Evince their
SALT, SULPHUR
AND
MERCURY,
TO BE
The True Principles of Things.
To which in this Edition are subjoyn'd divers Experiments and Notes about the *Producibleness of Chymical Principles.*
OXFORD,
Printed by HENRY HALL for Ric. Davis, and B. Took at the Ship in St. Pauls Church-Yard. 1680.

FIG. 4. The title-page of Boyle's "Sceptical Chymist". This is from the enlarged second edition. The first edition was printed in London in 1661.

time were headed by Dr Fell, Dean of Christ Church. In spite of considerable financial difficulties, partly due to the activities of the Stationers' Company, Fell nevertheless succeeded in laying down and exemplifying the principle striven for ever since, namely to produce well-printed works of genuine scholarship.

In 1672 Robert Morison, Professor of Botany at Oxford, published a monograph on the umbelliferae, and in 1680 the second part of his three-volume work on the "History of Plants". The first part was never written, and the third was completed from his notes by the younger Bobart after Morison's death in an accident.

In the early 18th century the Press published Halley's translations of Greek mathematical texts. After this there is a long period when, despite a great expansion in publishing, the scientific side was overshadowed by the eminence and number of works in classics, theology, philosophy, and history. It was during this time that the University Press moved first (in 1713) to what is now called the Old Clarendon Building, which is still used for meetings of the Delegates, and then in 1832 to the present Clarendon Press in Walton Street. Late in the 19th century scientific and mathematical books began to appear in numbers in the Press's publications.

In 1873 James Clerk Maxwell's "Electricity and Magnetism" was published, and a start was made on the publication of the "Index Kewensis". Both these works are still in print; the former in its fourth edition, revised by J. J. Thomson in 1904.

The growth of the scientific departments of the University, continuous if slow in the early stages, since the first Royal Commission appointed in 1850, has proceeded with increased momentum in the 20th century, and this growth has been reflected in the publishing lists of the Press. The Press, while its lists are open to the scholars of any or no university, is peculiarly and properly sensitive to the movement of ideas in its own University.

The 20th century saw a most important technical change in the production of books containing mathematical setting. Until about 1928 all the mathematics had been set entirely by hand. In close collaboration with the Monotype Corporation the craftsmen of the Press under the then Printer, John Johnson, and advised by mathematicians and physicists, perfected the means of setting much of this work by machine. The greatest fruit of their labours was the International Series of Monographs on Physics, first edited by R. H. Fowler and Peter Kapitza.

The first book in the series was Dirac's "Principles of Quantum Mechanics", published in 1930. Other series have followed this since the Second World War, those on the Physics and Chemistry of Materials, on Radio, on Meteorology, and on Numerical Analysis being now well established. The latest addition to the family is the Oxford Library of the Physical Sciences, a series of short, cheap, but authoritative accounts of modern scientific work, which owes its inception to the initiative of Sir Francis Simon.

Although this article has been confined to the consideration of books concerned in the main with the pure sciences, there has long been a tradition of the publication of books on medicine, and mention should be made of the impressive list of Oxford medical publications issued by the Press since the turn of the century.

THE BOOKSHELF

BIOLOGICAL SCIENCES

The Life and Death of Cells

By Joseph G. Hoffman (*Hutchinson, 1958, 288 pp., 35s. net*)

This is an interesting but in many ways infuriating book. Dr Hoffman does not seem to have decided at what level of audience he is aiming. As the blurb states, "the layman with a background of biological reading will find much to interest him and nothing that he cannot understand, although the book contains information at post-graduate level". This is true enough, but the crucial point is that the book contains no references whatever, so that the source and reliability of the information cannot be assessed. This is the greater pity because Dr Hoffman presents points of view which are in many cases somewhat novel and often enlightening His point of view in examining the properties of living matter is, he states, that of a physicist; and his discussions of cell physiology in terms of automation and the theory of stochastic processes is capable of stimulating some engaging lines of speculation. But in the absence of references, diagrams or even a mention of authors' names, one can never tell just what the author has in mind as the factual basis for his notions. There are also a considerable number of misprints, some of which might be rather deceptive to the layman; for instance, on p. 11, there is a mention of "the top eight-inch layer of tissue", when it must certainly be the top eighth-inch layer which is meant. Altogether this must be judged as an interesting book which is spoilt by inadequate preparation.

C. H. WADDINGTON

An Atlas of Airborne Pollen Grains

By H. A. Hyde and K. F. Adams (*London, Macmillan, 1958, 111 pp., 36s.*)

For many years, Mr Hyde and his collaborators have been gathering a mass of data about the occurrence of the pollen grains of different plants in the air at different times of day and year at a number of stations in the British Isles. This basic information, published from time to time in specialist journals, is of great value in a number of fields, but more particularly in the study of inhalant allergy. The aim of the present work is to provide a simple key to the ninety-two species which form over 90% of pollen grains commonly encountered in the atmosphere, and to describe and illustrate them with text and photographs. The text is admirably clear and such technical terms as have had to be used are carefully defined in a glossary. The gross structure of each pollen type described is defined by size (and size range) and reference to the more easily observed features of wall structure, pores, and polar field. Anyone who has attempted to obtain photomicrographs of pollen grains at high magnification will sympathise with some of the rather unrewarding results, particularly in the definition of fine and complex surface patterns. The task is all the more difficult when the subjects are in the fresh condition, retaining some or all of their cell contents, and when it is necessary to illustrate diversity of aspect by including a number of grains in a single field, all in the same plane of focus. Bearing in mind these very considerable difficulties, many of the photographs are notable technical achievements. The value of this book would have been significantly increased, particularly to readers seeking an introduction to the pollen analysis of recent organic deposits, if a list of similar genera had been included with each type described. It is true that there is an approximate parallelism between pollen morphology and plant taxonomy, but there are also many unrelated groups with very similar pollen grains which are a common source of confusion to the beginner. However, the authors do not claim an exhaustive treatment of a large field, and they have certainly achieved their aim of a useful volume, handsomely produced.

D. WALKER

Cytology and Cytogenetics

By Carl P. Swanson (*Macmillan & Co., 1958, 596 pp., 45s. net*)

Dr Swanson earns our gratitude by attempting the formidable task of writing a book which, in the words of the Preface, "brings together in integrated fashion the findings of cellular morphology, behaviour, physiology, and biochemistry, and then considers these data in their relation to inheritance and evolution". As this statement suggests, the book is in fact concerned more with nuclear cytology and chromosome behaviour than with such matters as cellular contraction, conductability, osmotic relations, and so on, which are usually classed as "experimental cytology", and have remained perhaps rather unfortunately isolated from cytogenetics. But even with this limitation, the field which Swanson has tackled is of enormous range and complexity. The last attempt to cover the whole of it was Darlington's epoch-making "Recent Advances in Cytology". Swanson's book, one may say, reviews the same field twenty years later, but his survey is conducted in rather different spirit. Whereas Darlington was concerned with the advance and defence of certain novel and stimulating hypotheses, Swanson is well aware that several of these theories have, in the intervening period, suffered the fate which is perhaps all that even the most penetrating thought can expect, namely to stimulate work which has revealed its inadequacy. Perhaps the most essential point, which is crucial for Darlington's theories but which remains unresolved by recent work, is the degree of multiplicity of chromosome strands at various stages of division. Where Darlington's thought requires a functional state of, say, doubleness, observation has not always succeeded in revealing it. The whole complex body of evidence, on these and many other matters, is summarised with admirable clarity by Swanson. His review is relatively impartial, though it is apparent that his opinions tend towards the Sax school of interpretation. But this bias is not pressed. In general he has been very successful in his aim "to delineate the *certain* from the *uncertain*, the *hypothesis* from the *proven observation*, the *casual relationship* from the *disconnected fact*".

There is a long, but, of course, by no means complete bibliography, perhaps a little unduly weighted in favour of American references; and a useful index. Apart from its value as a balanced evaluation, the book will find a wide welcome as a work of reference.

C. H. WADDINGTON

A Study of Blackbirds

By D. W. Snow (*London, George Allen & Unwin, 1958, 192 pp., 21s.*)

It is a well-known paradox that the familiar birds of our gardens and towns have often received less attention from ornithologists than those species living in more remote and exciting places. Thus, until recently, far more detailed research had been done on penguins, fulmars, and shearwaters, for example, than on house sparrows, feral pigeons, and blackbirds. David Snow has helped notably to redress the balance. Working at the Edward Grey Institute at Oxford, he found in the Botanic Garden outside his window a tame and thriving blackbird population, and he was able to trap and colour-ring many of them, and so, over four years, study their individual lives. The result is a fascinating book which throws light not only on a common and rather neglected

species but also on more general problems of behaviour and population dynamics.

Originally, as he points out, blackbirds were shy birds, living in wooded country with more or less thick undergrowth, and avoiding the neighbourhood of man. Now they are familiar garden birds in many parts of Europe (as well as in New Zealand and south-eastern Australia, where they were introduced some ninety years ago) and have penetrated even into the centre of large cities. This is a comparatively recent development. The colonisation of gardens began between 100 and 150 years ago in north-western Europe, and reached parts of Scandinavia only during this century. The move into cities is still more recent; in London, the Bloomsbury squares were colonised within the last twenty-five years. There is some evidence that in recent years, too, there has been a decline in the numbers of its less aggressive relative, the song thrush; it would be interesting to confirm this and ascertain if there is any connexion.

Snow's careful studies show conclusively how the blackbird thrives in its new environment. In towns and suburbs it tends to start breeding (and singing) earlier; in this, he suggests, more light, increased wakefulness, and greater warmth may all play a part. The density is much greater, with about ten times as many pairs per hectare in the Botanic Garden as in the broad-leaved woodland at Wytham, a few miles away. And, though clutch sizes are smaller, more young are produced, mainly because there is less predation. So each year there is a surplus of young blackbirds in the Botanic Garden and they must fight for territories in the spring with the older birds (which usually keep their mates and territories for life) or move elsewhere and perhaps further extend the range of the species.

All these researches are in the best tradition of the Edward Grey Institute, world-famous for its work on bird population problems, but Snow does not confine himself to statistics. He gives us also a fascinating picture of the lives of blackbirds throughout the year; their food, territorial battles, sexual behaviour, song, calls, and plumage changes. Many blackbird displays have been infrequently reported, and then sometimes misunderstood; for, as he shows, confusion is possible at times unless the individual history and status of the birds is known. His clear descriptions of display are well matched by the delightful and accurate drawings by Robert Gillmor. Here is a wealth of detail to entrance the student of animal behaviour, and the whole work is a striking example of how much can be elucidated by simple techniques, understanding, and painstaking observation.

S. CRAMP

NEWNES

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DISPOSAL OF RADIOACTIVE WASTE

K. Saddington, M.Sc., F.R.I.C., and W. L. Templeton, B.Sc., M.I.Biol.

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NEWNES

Common Names of British Insects and Other Pests

Technical Bulletin No. 6, Ministry of Agriculture, Fisheries & Food (*H.M.S.O., 49 pp., 7s. 6d.*)

Many different kinds of people are concerned with insect pests: housewives and advisory entomologists, farmers, and chemists who manufacture insecticides. Some will use the common English names and others the scientific nomenclature. Popular names are sometimes ambiguous, because there are often several names for the same insect. Thus, horseflies (of the family Tabanidae) are also called clegs, stouts, breeze flies, dun flies, and thunder flies. Alternatively, the same may be used for quite different insects (as "sandflies" for *Culicoides* spp. and also for *Phlebotomus* spp.). Biologists, however, should not be complacent, for scientific names are quite often altered (when prior descriptive papers are discovered) so that confusion arises here too.

To clarify the position, lists of the more important British pests (insects, mites, and eelworms) were prepared a few years ago, by experts from the Ministry of Agriculture and the Association of Applied Biologists. Now a revised comprehensive list (in alphabetical order) of agreed standard names both popular and scientific, has been prepared. In addition, there are lists of synonyms, both common and scientific. This will be a most useful handbook for many.

J. R. BUSVINE

The Kew Series

British Wild Flowers

By Patricia Lewis (*376 pp.*)

British Trees and Shrubs

By R. D. Meikle (*244 pp.*)

(*London, Eyre and Spottiswoode, 1958, 25s. each*)

The botanical staff of the Royal Botanic Gardens, Kew, have planned, written, and edited this series of five volumes to serve as a guide to native and naturalised plants in Britain. "British Wild Flowers" and "British Trees and Shrubs" are the first two volumes of this series. The other volumes are "British Seaweeds", by Patricia Lewis, "Garden Shrubs and Trees", by S. G. Harrison, and "British Ferns and Mosses", by P. G. Taylor. The Kew Series is designed for use by students, amateurs, and nature-lovers, and provides scientific information and technical terms as well as plant lore. The illustrations (colour plates and black-and-white drawings) have been specially prepared for the series; detailed keys are provided for identification.

Spiders, Scorpions, Centipedes and Mites

By J. L. Cloudsley-Thompson (*London, Pergamon Press, 1958 228 pp., illus., 50s.*)

Arthropods on land are compelled to remain relatively small, because when they moult, they temporarily lose their skeletons; and for mechanical reasons this is much more serious for a large animal than a small one. There are many physical and mechanical consequences of being small and the world encountered by small creatures must seem very different from the one we know. One obvious consequence is that terrain becomes much more variable. A field, which represents a uniform environment to a man or a cow, provides dozens of micro-environments for small creatures; in loose soil, under stones, in puddles, inside and on plants, and so forth. Hence the extraordinary richness and variety of different forms of arthropod which have striven to occupy these various ecological niches.

Of the different kinds of land arthropod, the insects are by far the most numerous and varied, probably because of their invaluable development of wings. Insects, too, make most direct contact with human affairs by the damage they do and the diseases they carry. Therefore, insects are most intensively studied, both by naturalists and by applied biologists. Although this is inevitable, it is no reason for neglecting the other land arthropods, which combine great interest and remarkable peculiarities. Dr Cloudsley-Thompson's book is a valuable contribution to fill the need for an up-to-date account of these neglected groups. Some things he discusses in a general way; for example, the devices of various forms for respiring and for avoiding water loss; but most of the work is an account of the life histories and ecology of the various orders. This is the aspect which interests him most and to which he has made many contributions. The various unusual animals are well illustrated by diagrams and excellent photographs. The text is concise and well documented, but written with some lighter touches to avoid a textbook style. For examples: "In the silence of the night, the desert Solifugae race about, conduct their amours and glut themselves with innumerable insects to supply their requirements during the winter sleep"; and "In 1942 in Libya, my troop corporal kept a short-legged black *Rhagodes* in a biscuit-tin on the back of his tank and fed it almost entirely on scorpions."

As the author suggests, this book should be appreciated by natural history workers at home and abroad and upper school biology teachers as well as by many university students.

J. R. BUSVINE

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ASTRONOMY, ASTRONAUTICS and MATHEMATICS

The Face of the Sun

By H. W. Newton (*A Pelican book, published by Penguin Books Ltd, Harmondsworth, Middlesex, 1958, 204 pp., 3s. 6d.*)

There is a well-known rhyme about the pelican in which the creature's beak is eulogised for its capacity for storage. Messrs Penguin Books Ltd certainly ensure that their offspring follow the poetic pelican, for here we have 204 pages of first-class information on the sun together with 16 excellent plates, 37 line drawings, and an index, all for less than the cost of a packet of 20 cigarettes.

Mr H. W. Newton is well known to astronomers as a solar observer and an expert on solar phenomena. For forty-two years he has served on the staff of the Royal Greenwich Observatory and for most of this time has been in charge of the solar department. He should now become better known to a wide circle of readers, for this book is to be commended highly to all who wish to have some knowledge of the sun and its behaviour.

After a brief introduction, Mr Newton deals, in a simple but sensible fashion, with the sun and its radiation, and in his second and third chapters discusses early sunspot observations. More modern approaches follow, together with an admirable description of sunspot features, including a chapter on flares and prominences, so important to the solar physicist and to those working as International Geophysical Year observers. Terrestrial magnetism and its associations with solar activity are described and a brief chapter is also included on radio-astronomical observations. Lastly, there is a succinct chapter on the aurora, followed by some thoughts on sunspots and possible terrestrial events which have been conjectured as connected with them. In the final chapter Mr Newton gives a brief but lucid description of the stellar system; appropriate as we must remember the sun itself is a star (the only "blot" in the book occurs in this chapter in the line-block euphemistically entitled "December night sky looking south from London"—this is no subject for a line-block and could well have been omitted). The author has written four appendixes: one on the solar spectrum, another on the twenty-five greatest sunspots recorded between 1874 and 1954, the third on the optical systems

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of telescopes, and finally an appendix on the IGY.

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THE SOCIAL SCIENCES

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By Hilde T. Himmelweit, A. N. Oppenheim, and Pamela Vince (In collaboration with D. Blumenthal, E. W. Croft-White, A. G. Maclaine, M. Newell, N. A. Standen, and J. Wheldon) (*London, Oxford University Press, for the Nuffield Foundation*)

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The three main conclusions appear to be: first, some popular ideas about the effects of television on children are inconsistent with the results of the survey; second, the effects of television appear to vary with the age, sex, intelligence, home background, and personality of the child; and third, television exercises no powerfully dramatic or transforming effect on the child. A great number of other points of interest emerge which will no doubt provoke wide discussion.

One must pay tribute, on the one hand, to the zeal of the investigators in generating a vast mass of detailed material and, on the other, to their diligence and assiduity in attempting to make sense of it. At the same time, some readers may feel certain reservations about the adequacy of the survey approach as a whole. Not that the factual outcome is in question, for example, that *X* per cent of the children replied in this way and *Y* per cent replied in that. What is in question is the significance of the multitude of percentages with which the reader is confronted and the nature of the inferences that may be drawn from them.

The use of questionnaires or inventories of personality, the validity of which is unknown, is, after all, a rather superficial method which cannot be expected to come to grips with complex issues. The most appropriate method of studying the effects of a *mass* medium is not necessarily a *mass* survey. An intensive *experimental* study of a relatively small group of children might prove to be more productive.

Survey techniques doubtless have their useful part to play in public-opinion polls but they are no substitute for a more rigorous and searching experimental method. The investigators were surely aware of this but probably felt they were justified in employing a method which promised quick results on a large scale.

J. COHEN

Social Change in the South Pacific: Rarotonga and Aitutaki

By Ernest Beaglehole (*Allen & Unwin, 1957, 268 pp., 28s.*)

Dr Beaglehole's book falls into two parts. The first tells the story of Cook Islands society as it developed in response to the various influences exerted upon it by outsiders, notably the missionaries who were established there from 1821. The second is a picture of the contemporary society of Aitutaki, based on two months of intensive study. From this Dr Beaglehole draws conclusions as to the character structure of the Aitutakians which he uses to throw light on the whole process of development.

Although the islanders had some contact with other Europeans than the missionaries who directed the activities of the native teachers whom they placed on the island, their history can be seen largely in terms of their reaction to the strict authority which the London Missionary Society exercised during the sixty-odd years before they came officially under British rule. Dr Beaglehole pauses from time to time and surveys the point reached in relation to a list of variable factors, namely: influences of locality, character of immigrants, race difference, numerical influences (proportion of immigrant to indigenous population), momentum (degree of insistence by dominant groups on change), effective contact (between immigrant and indigenous groups), factor of adaptability, and prestige factors. The list actually begins with "time sequence", but the entries under this are not comparable, and the heading would merely seem to mean that it is necessary to give a chronological account of any developing situation. Although in his

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The investigation itself consisted essentially of a survey of the opinions of ten-year-old and thirteen-year-old children in primary schools. Some 4000 children were involved in five cities. Supplementary data were obtained from children's diaries, interviews with parents, so-called inventories of personality, and questionnaires to teachers. The investigators concentrated on two types of effect: that due to the time spent on viewing and that due to the content of the programme.

The three main conclusions appear to be: first, some popular ideas about the effects of television on children are inconsistent with the results of the survey; second, the effects of television appear to vary with the age, sex, intelligence, home background, and personality of the child; and third, television exercises no powerfully dramatic or transforming effect on the child. A great number of other points of interest emerge which will no doubt provoke wide discussion.

One must pay tribute, on the one hand, to the zeal of the investigators in generating a vast mass of detailed material and, on the other, to their diligence and assiduity in attempting to make sense of it. At the same time, some readers may feel certain reservations about the adequacy of the survey approach as a whole. Not that the factual outcome is in question, for example, that *X* per cent of the children replied in this way and *Y* per cent replied in that. What is in question is the significance of the multitude of percentages with which the reader is confronted and the nature of the inferences that may be drawn from them.

The use of questionnaires or inventories of personality, the validity of which is unknown, is, after all, a rather superficial method which cannot be expected to come to grips with complex issues. The most appropriate method of studying the effects of a *mass* medium is not necessarily a *mass* survey. An intensive *experimental* study of a relatively small group of children might prove to be more productive.

Survey techniques doubtless have their useful part to play in public-opinion polls but they are no substitute for a more rigorous and searching experimental method. The investigators were surely aware of this but probably felt they were justified in employing a method which promised quick results on a large scale.

J. COHEN

Social Change in the South Pacific: Rarotonga and Aitutaki

By Ernest Beaglehole (*Allen & Unwin, 1957, 268 pp., 28s.*)

Dr Beaglehole's book falls into two parts. The first tells the story of Cook Islands society as it developed in response to the various influences exerted upon it by outsiders, notably the missionaries who were established there from 1821. The second is a picture of the contemporary society of Aitutaki, based on two months of intensive study. From this Dr Beaglehole draws conclusions as to the character structure of the Aitutakians which he uses to throw light on the whole process of development.

Although the islanders had some contact with other Europeans than the missionaries who directed the activities of the native teachers whom they placed on the island, their history can be seen largely in terms of their reaction to the strict authority which the London Missionary Society exercised during the sixty-odd years before they came officially under British rule. Dr Beaglehole pauses from time to time and surveys the point reached in relation to a list of variable factors, namely: influences of locality, character of immigrants, race difference, numerical influences (proportion of immigrant to indigenous population), momentum (degree of insistence by dominant groups on change), effective contact (between immigrant and indigenous groups), factor of adaptability, and prestige factors. The list actually begins with "time sequence", but the entries under this are not comparable, and the heading would merely seem to mean that it is necessary to give a chronological account of any developing situation. Although in his

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conclusions he suggests that the unique combination of these factors in the Cook Islands has resulted in a unique history of social change, and gives some comparisons with other territories to support his argument, one would like to be told in much more detail what the differences are.

As distinguishing features of Aitutaki character-structure, Dr Beaglehole mentions their easy-going nature, their sociable gregariousness, their sensitiveness to group judgments, their aggressiveness, and finally—a heading which seems to belong to a different category—"Prestige and Status". These features are discovered partly by the use of Rorschach tests and partly from "the observations made by missionaries and anthropologists". Dr Beaglehole seems himself to have observed their "casualness", as a result of which no job is ever done properly. One seems to have heard this quality ascribed to many categories of people of many different ethnic origins, and, curiously, almost always by their employers. He also notes that they have such a desire for "the physical contact that comes from being closely packed in a crowd" that if this is frustrated it "amounts almost to a craving". How did he ascertain this remarkable fact?

His study is offered as a demonstration of the importance of psychological factors in social change.

L. P. MAIR

The Testing of Negro Intelligence

By Audrey M. Shuey (*London, Holborn Publishing Company, 1958, xv+351 pp., 30s.*)

This is an exasperating book. Of 318 pages of text, 317 contain a useful and painstaking survey of about 240 studies dealing with the intelligence of Negroes in the United States. In these pages there is no original thought, and no critical examination either of the meaning of intelligence tests or of the concepts of race and heredity. On p. 318 the author draws a conclusion which is not warranted by the preceding exposition. The reader, however, need not wait for the last page. Prof. Garrett, in his foreword, gives it away when he concurs with the author, that there is a "racial basis" for the difference between the scores of Negroes and white persons on intelligence tests.

Dr Shuey's report on individual researches is fair and objective. Many, though not all of them, find the *average* test score of Negroes is lower than that of the American white population. For pre-school children the average difference is about 9 IQ points. At later stages many studies find greater differences. The two distribution curves show, however, considerable overlap, and the variation within each group is, of course, much larger than the variation between groups.

Much of the research reported in this book deals with certain environmental factors which modify the average score on intelligence tests. Northern Negro children, for example, do consistently better than those in the border states, who, in turn, surpass Southern Negro children. Urban Negro children perform better than those in rural areas.

Several investigators have attempted to compare Negro and white children of similar economic background, a comparison which is exceedingly difficult in view of the existing discrimination against Negroes which makes it hard to find comparable groups in large numbers. Such studies report a superior average for white children.

These findings may come as a shock only to those decent but naïve Americans who would rather be colour-blind than admit any difference between Negroes and whites. Others have accepted these facts as well established. Just as well established among psychologists, however, is the critique of efforts to match Negroes and white persons for environmental factors. The psychologically relevant environment consists not only of economic factors. The stigma of social inferiority, driven into the consciousness of every American Negro through the existence of prejudice and discrimination is, perhaps, the most pervasive environmental factor in their lives. No matching for the impact of this situation is realistically possible in research. This qualification must be kept in mind in the interpretation of studies using groups matched on other environmental factors.

Dr Shuey is, of course, not responsible for any shortcomings in the research she reviews. Where one begins to take issue with her is on the last page. There she draws the conclusion that the material supports the idea of racial differences in intelligence. Her own words are more vague than Prof. Garrett's, but both imply that race is the explanation for the lower scores. In other words, Dr Shuey uses a correlation as if it indicated cause and effect—a fallacy which every elementary text of statistics condemns. The genetic problem of hereditary intelligence is as yet unsolved. No one has discovered a single gene for intelligence, and many biologists doubt that such a gene will ever be discovered. On the other hand, the intricate interaction between hereditary equipment and environmental factors is well documented in many studies. In any case, even if a simple hereditary mechanism for intelligence were discovered, the American Negro might present considerable problems in its application, for there is little pure racial stock. Current estimates are that about 80% of American Negroes have some Caucasian or Indian ancestry; at best 20% can claim pure African "blood". Whether the race mixture came from the more or the less intelligent part of the white population is an unanswerable question.

Since the mechanism for the inheritance of intelligence is not known, it is not possible to assert that heredity will vary in proportion to the degree of white ancestry, whatever its level of intelligence. Nevertheless, one study is perhaps worth noting, even though it was not included in Dr Shuey's otherwise extensive review. In a group of gifted Negro children with IQs between 125 and 200, no relationship was discovered between IQ and amount of white ancestry within this group, nor was the group as a whole significantly different in this respect from the general American Negro population.

Had this book dealt with a subject of less far-reaching social implications, one might have felt that the usefulness of the data collection more than compensated for the erroneous conclusion. When the case of Negro intelligence is involved, the situation is different. The suggestion that whatever difference there is in scores on intelligence tests has a biological basis might well contribute to denying coloured people the chance of a decent environment, which may enable them to make their full contribution to civilisation. Neither the United States nor this country can afford to be misled on this topic.

M. JAHODA

Management and Technology

By Joan Woodward (*London, H.M.S.O., 1958, 40 pp., 2s. 6d.*)

This booklet is the third in a series entitled "Problems of Progress in Industry", commissioned and edited by the Department of Scientific and Industrial Research. It is based on a survey of the management organisation of one hundred firms in south Essex, and on a number of case studies supplementary to the survey. The booklet undertakes an assessment of the relation between success in industry and adherence to the "rules of management" taught in British technical colleges. The full report will be published later with a discussion of the theoretical implications for management studies; this booklet is a digest of that report.

WORLD HEALTH

The First Ten Years of the World Health Organisation

(*World Health Organisation, Geneva, 1958, 540 pp., no price stated*), and

Ten Steps Forward, World Health 1948–1958

By Ritchie Calder (*WHO's Division of Public Information, Geneva, 1958, 68 pp., 2s. 6d.*)

Teams of a dozen doctors working on blue babies at Johns Hopkins Hospital, at Guy's Hospital, at Liverpool, and elsewhere, save scores or between them, hundreds of children for a better life. They get and deserve publicity in medical and lay Press. Do we hear enough of the teams who have cured 15 million children and adults of yaws—a disease, to quote Ritchie Calder, which "disfigures and destroys not only the body but the spirit—a tortured misery from infancy to death", but which with one shot of penicillin disappears in ten days? Millions more are being saved from tuberculosis, malaria, from kwashiokor, cholera, etc., by doctors in many countries working in collaboration with the World Health Organisation. Too often the comment made is that we can't afford to save these lives. It may well be true that two-thirds of the world's inhabitants are hungry and that the food they get is less than twenty years ago, but that is a challenge which, like the problem of ill health is being tackled by United Nations agencies.

The brilliant successes on a small outlay of WHO need to be widely known. They concern each one of us. The prosperous part of society controls epidemics to protect itself as well as for the benefit of that other world, the poor. And if we all involved ourselves in the work of WHO by being interested, not necessarily by going out to work in the field, the co-operation between nationals typical of WHO might become diffused so widely as to make war much less likely. WHO is a very practical body; it works only in co-operation with local workers bringing knowledge but not doing the job for them. It is too poorly financed to be starry-eyed and unpracticable in its field work.

Despite admirable field work, WHO has not consistently had good relations with official medical opinions. This arises in part from medical lack of interest in prevention as opposed to treatment and partly from a rather inept excursion in the early days. The International Labour Office asked for a report on the work of doctors. WHO appointed a Consultant Group which submitted a report to the Executive Board of WHO, which passed it on to ILO. This widely circulated report gave an unasked-for opinion that a salaried service is better than fee-for-service or capitation payment for doctors. Whether this view is right or wrong, it seems curious that neither the group nor the Executive Board appeared to notice that the group was composed solely of salaried doctors, none in active practice, and that no effort had been made to discover the views of the World Medical Association, which was stung into a protest that the majority of doctors reject the view expressed.

Ever since its foundation, WHO has also drawn some criticism that its definition of health, as "a state of complete physical, mental, and social well-being", is unreal. It could be argued that it is better to speak as did R. R. Bomford, of health as a reasonable degree of adaptation to one's physical and social environment, and it could be argued that minor degrees of neurosis are what make some men unusually hard-working, unselfish, and so on. But that it aims very high can be accepted as a merit of the definition

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and certainly its inclusion of social factors showed unusual wisdom.

"The First Ten Years of WHO" is a 500-page book, illustrated with photographs and maps. It gives detailed information and it is an important source book of great interest and value to workers in many fields of medicine.

"Ten Steps Forward" has 44 pp. of text and 24 pp. of pictures. It describes ten major pieces of work done by WHO. Ritchie Calder has made a vivid, immensely readable book which should be enjoyed by all lively minds. The sixth form of schools, arts and science students at universities, nurses and medical students, Townswomen's Guilds, Women's Institutes, can get the excitement of achievement from it. The writing is memorable. To read of "chimney-sewage" spread through the atmosphere is to be given a new feeling on the smoke problem. The subjects range from malaria to mental health, from a nursery school in Ethiopia to the problems of the child deprived of love. Did you know that throughout the war, with the concurrence of the belligerents, the Section of International Quarantine (now included in WHO) circulated information for epidemic control?

The achievements in international co-operation of the specialised agencies enables one to retain hope for mankind. The more that is known about their achievements the better. Ritchie Calder has done a great service in writing "Ten Steps Forward" for all can read and be inspired. WHO's work is a great work, and in these two books the story is well told.

R. MAC KEITH

World Health

By Fraser Brockington (*A Pelican Book, 1958, 405 pp., 5s.*)

A writer on the subject of "World Health" must possess a knowledge of modern concepts of the public health movements throughout the nations; and he ought to be acquainted with the enormous and increasing activity of the health services. Prof. Fraser Brockington has this wide learning, and his intimate knowledge of many health programmes of countries in different stages of development place him in a fortunate position. In this book he gives an authoritative account of the meaning of the term "health" and of "public health" and describes how the pursuit of health has been conditioned by geography, beliefs, customs, family life patterns, population movements, and nutrition—to mention only a few of the many factors involved. The author shows also how in modern times similar influences are in operation, although often complicated by urban growth and industrial development. Many references are provided in the book for those who wish to make a deeper study of the various factors.

The diseases of the nations are broadly described under four main headings: infectious disease, degenerative conditions, malnutrition, and mental disorders. The volume gives an account, supported by statistics and illustrated by charts, of the present-day health situation in different regions of the world. From this it is possible to understand why so many clearly marked patterns of ill health exist. The developed and the so-called "underdeveloped" countries are contrasted; the changing picture is described in the light of the evolution of public health practice. This leads us to a very informative account of the establishment and the present activities of the single international agency which is directly concerned with these problems of health and sickness—the World Health Organisation. The book carries a foreword by the Director-General of this organisation.

The author's commendable bias in the direction of factual information is represented by the simple fact that nearly half the book is devoted to vital and health statistics, their purpose, sources, inadequacies, and needs. On the new and advancing line of morbidity statistics and the measurement of levels of health some of the most recent developments are described, but quite rightly the emphasis is laid on the promotion of health rather than on the mere control of disease. The positive outlook of the book is one of its virtues.

Public health, like other biological sciences, is unremitting in its search for new laws, principles, and relationships with cognate studies. In this search there is ample room for authoritative opinions, and the author has frequently expressed categorical views, although it is not always clear how far he agrees with them and has made them his own. No doubt the reader will occasionally disagree, especially on such controversial subjects as population growth and the intricacies of family life. It is just from this point of view, however, that Prof. Brockington has written a stimulating and thoughtful book; and now that public health is no longer a concern solely for doctors, nurses, and sanitarians, this work should also appeal to politicians, social workers, and to those engaged in planning and administration. Matters of health have become so personal to all of us that the publication of a "Pelican" book is an attainable addition to our collection of books; and the international scale of its enterprise should ensure wide appreciation.

J. M. MACKINTOSH

HISTORY and ECONOMICS

Geschichte des Geigy Unternehmens von 1758 bis 1939

By A. Bürgin (*Basle, Birkhäuser AG., 1958, 322 pp., 25 fr. Swiss.*

Geigy heute

By M. Kutter (*Basle, Birkhäuser AG., 1958, 288 pp., 25 fr. Swiss.*

Business histories have been appearing for many years, but few are useful records of the development of an enterprise, because their authors consider their task done if they provide a medley of photographs and a text replete with fulsome praise of the company's activities. The two volumes written for the J. R. Geigy company of Basle to commemorate the bicentenary of its foundation are therefore a welcome and significant exception to this rule.

Dr Bürgin, who has written the first volume, is an economic historian, and he narrates skilfully how the small merchant business founded by J. R. Geigy in the middle of the 18th century to trade in dry-saltery and druggists' goods, began manufacturing vegetable dyeing and tanning materials in the 19th. During the 1860's Geigy's successors started producing coal-tar dyestuffs, and these remained the company's principal business for the next seventy years. The author describes not merely the growth of the Geigy works but also that of the dyestuffs industry in Basle which paralleled it, and he compares the activities of the Swiss firms with those of other countries so that the book can fairly be described as a comprehensive account of the changing pattern of the dyestuffs industry as a whole.

The second volume deals with the twenty eventful years to 1957, and is of unusual interest since it is an account (written from within) of how the company adapted itself to the profound changes which have taken place in organic chemistry in recent years. In this period turnover rose from about £4 million to £42 million, employment by the parent company from 900 to 2800, and the entire group now has over 8000 workers and staff in eighteen countries. By any standards these are impressive figures and the book describes this remarkable expansion in terms of research, production, and sales. The order adopted (research occupies first place) is significant and explains why the entire basis of Geigy's activities has been transformed so that dyestuffs at present account for only two-fifths of the

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business, the remaining three-fifths being contributed by new products, chief among them pharmaceuticals, pesticides and insecticides (notably the moth-proofing agent "Mitin" and that household word DDT), as well as plasticisers and textile auxiliaries.

The directors of J. R. Geigy are to be congratulated for allowing students of history, chemists, and, not least, business men to gain such a thorough insight into the working of their company. At a time when enterprise, adaptability, and research-mindedness are urged on British firms, it is both profitable and stimulating to read what this Swiss firm has achieved, not only in Basle, but also, as appears from pp. 185–8, in the U.K.

The two volumes are valuable as to content and admirable in their presentation. It is to be hoped that they will not remain for long in splendid isolation. L. F. HABER

The Economic Development of Detergents

By W. J. Corlett (*Gerald Duckworth & Co. Ltd, 1958, 25s.*)

The definition of a detergent is something that cleans; Mr Corlett deals with the two most important classes of detergents, soaps, and detergents based on synthetic surface-active agents. The emphasis throughout is on the ingredients employed, the methods of manufacture, marketing and sales of the finished products. The technical details of manufacture and the chemistry of the ingredients themselves is kept to a minimum and the book is clearly designed for those wishing to gain an overall picture of an industry which has experienced a number of major changes in the last few decades.

The book starts with a distinction being drawn between products based on soap and those based on synthetic surface-active agents, and then follows a review of production and consumption in the U.K. and the U.S.A. up to 1955.

Chapter 2 deals with the structure of the market in the U.K. The main suppliers are listed and their activities briefly surveyed. Then comes an account of the manufacture of soap from the earliest times up to the present. Manufacturing methods are compared and contrasted and the economic aspects are considered in some detail. In Chapter 4 the history of synthetic detergents is traced back to 1831, when Frémy discovered the sulphonated oils. Mr Corlett shows how a combination of factors led to the search for other surface-active agents, initially for specialised uses in industry, but subsequently for use as the active ingredients of modern synthetic detergents.

This leads to a discussion of the builders and fillers which are incorporated in detergent products in order to give the necessary cleansing, storage, and handling properties. An analysis of the marketing of detergents follows in Chapter 6, with particular reference to consumer research, advertising, price policy, and competition generally between the firms involved, and the book ends with an overall survey of the developments and innovations which have occurred in the industry over the last half-century.

One of the hazards that an author faces in writing a book of this type is of being anticipated. How long, in fact, can one spend on the collection and preparation of the material before someone else produces a book on the same lines? The hazard in the present case has been the greater because, for one reason or another over the last few years, detergents have figured prominently in the newspapers, and this has drawn attention to the lack of books for the non-specialist dealing with how they are made and how they are sold.

Mr Corlett has been somewhat anticipated. P. A. R. Puplett has already published a rather similar study, and in the intervening period it does not seem to have been possible to obtain very much new data or reach substantially different conclusions.

Nevertheless, Mr Corlett has produced an interesting and readable account of an industry which, perhaps justifiably, has not been too keen to reveal all its secrets. The material is well selected, the conclusions sound. Perhaps the presentation would have been improved by the use of a number of sub-titles in each chapter, and the reviewer would have also liked to have seen some of the data presented in graphical form, but these are minor criticisms. N. PILPEL

Wüsten, Deiche und Turbinen

By H. W. Flemming (*Musterschmidt, Frankfurt, 1957*)

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known before. The two works, equally first rate in production, clarity, scholarly thoroughness without losing the wood with the numerous trees, would merit translation, for it is unlikely that, apart from that monumental work, Charles Singer's "A History of Technology", we shall in the near future receive books such as the ones mentioned here.

The first is no less than a history of the harnessing by man of hydraulic power and the wresting of land from the waters through the ages. Water is the key-word and note of this well-written work, a major contribution indeed to the history of engineering, dyke building, and dam erecting. Apart from every other practical angle it is an inspiring study by an eminent European expert whose membership of several European commissions (for example, European Productivity Agency consultant) assures the reader that the European and global aspects of engineering achievements of all nations are never lost sight of. A huge wealth of material and many fine illustrations are presented in a volume that would gain prizes in book production in any international contest. The narrative is clear, precise, and easily digestible, despite the wide and deep learning and practical expertise of the author.

The second book, equally ambitious in scale and equally clear in its endeavour of presenting an historical perspective of engineering science, tackles the absorbing field of "energy and man" from the point of view of energy, not so much as the former work, the energy carried by water, but certainly with ample reference to it, where it is central to the story. The author is probably better known to British economists and engineers as a man of international economics and world travel and cosmopolitan stature. J. HORNE

The Ferodo Story

Published by Ferodo Ltd. (1957, 61 pp., illustrated, unpriced), traces in non-technical fashion, the development and use of braking materials. It tells the story of the transition from Herbert Frood's experiments in a small hut in the garden of his house sixty years ago to the present works covering sixteen acres at Chapel-en-le-Frith, stated to be the largest single unit in the world devoted to the manufacture of brake linings and clutch facings.

The control of the speed of rotation of wheels is a fundamental requirement of life as lived today, and the present reliability of clutches and brakes in modern machinery is certainly something to be wondered at when one reads that "when London motor-buses first came on the roads fitted with leather clutch-linings, these sometimes had to be replaced twice day . . .". E. S. H.

ENGINEERING and METALLURGY

The Electrical and Magnetic Properties of Solids

By N. Cusack (*London, Longmans, Green & Co., 1958, 427 pp., line illustrations, index, 45s.*)

This book covers a much wider field than its title would indicate. Its earlier chapters provide a survey of the fundamental principles of electrical engineering, and form a most useful starting-ground for the study of every aspect of electrical engineering.

The author, who is Lecturer in Physics at Birkbeck College, London, says in his preface that the book is intended primarily for students reading for honours and special degrees in physics, and for those commencing post-graduate research.

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CHAPMAN & HALL

This level clearly implies that the potential reader must have a fairly extensive knowledge of classical physics and a sound mathematical equipment. With these two props securely in his hands, the reader may look forward with pleasure to exploring a masterly exposition of the author's main subject and much else besides.

He first introduces the free electron gas model of a metal, and proves, in a deceptively easy fashion, the existence of free electrons in metallic substances and discusses their energy levels. The all-important Fermi level is clearly defined.

There is a smooth transition to the consideration of work functions and contact potentials: and from these arguments the mechanism of thermoelectric and photoelectric effects is gradually and naturally made clear.

Then comes the sections which are of vital interest to electrical engineers. Electrical conductivity in metals and in semiconductors is discussed exhaustively, but always in a manner which is absolutely clear.

Magnetism is next dealt with, in all its manifestations. The succeeding chapters deal with superconductivity, dielectrics, and piezoelectricity. All are shown to arise out of the same basic physical properties of sub-atomic particles.

Almost the only field Dr Cusack does not explore is that relating to the mercury arc. There seems, from the literature, to be some exploration still to be done in the layer above the cathode in a mercury arc rectifier, and it would have been interesting to have read Dr Cusack's view on the physical state existing in this unique metal under operating conditions in the arc.

The book is extraordinarily well written, but not always very profusely illustrated: several discussions would have been clearer with the aid of more diagrams.

This is a work which can be commended in the highest possible degree.

J. H. M. SYKES

A Dictionary of Metallurgy

By A. D. Merriman (*McDonald & Evans Limited, 1958, 401 pp., 290 figs., 3 tables, 126s.*)

Specialist terms, execrated as jargon though they may be by the literary or used as weekly ammunition by the more whimsical of Sunday-paper humorists, are essential to any branch of science, and all who wish to comprehend a scientific subject must learn the appropriate language. In this particular aspect of cybernetics a dictionary might appear to be a very welcome aid, and the producer of so comprehensive a lexicon as Dr Merriman's Dictionary of Metallurgy a public benefactor.

There are fundamental difficulties, however, in the compiling of such a work as this. Words used by scientists often represent complex sets of ideas and cannot be defined except in terms equally specialised in meaning. An inquirer needing the help of the dictionary, therefore, will not necessarily understand the answer he finds there. Yet to impose on the author the condition that he should use in his definitions only words and concepts familiar in everyday life would extend each definition to the length of a textbook.

Dr Merriman has not found a complete solution to these difficulties and it is to be feared that many of the definitions in his book will be understood only by those who have no need of them. Furthermore, in including the whole of metallurgy within his scope the author has added very considerably to the difficulties of his task, because modern metallurgy, described by Dr Merriman as embracing the practice and science of extracting metals from their ores, the refining of crude metal, the production of alloys and the study of their constitution and properties, etc., covers the whole range from engineering to the more mathematical aspects of solid-state physics. No one could hope to display equal authority in all parts of so broad a subject, and experts in some of the fields, including the properties of the rarer metals and the theory of metal deformation, for example, will find occasional inaccuracies due largely, no doubt, to the need for compression.

Books as well produced as this one are a delight that must be paid for, and at £6 6*s*. Merriman's Dictionary offers metallurgy at about 0·2 pence per word. This figure is high, compared, for instance, with the "Concise Oxford Dictionary" at roughly 0·005 pence per word. Crude economic considerations, therefore, as well as the physical dimensions of Merriman's book prompt the suggestion that the specialist volume should have been purged of all words used by metallurgists in their ordinary sense. "Discrete" and "foam" are two concerning which Merriman and the "Concise Oxford Dictionary" are in complete agreement.

One hears of determined people who set out to learn an unfamiliar language armed only with a standard work of literature and a dictionary. If metallurgical counterparts of these exist, they will find in Merriman a true friend. Research workers and others concerned with metallurgy, for whom the book is avowedly intended, will more probably, however, pay to Dr Merriman a deserved tribute for the skill and courage he has brought to bear on his immense task, and turn for information to the more convenient sources to which their own specialised knowledge gives them access.

M. K. MCQUILLAN

Advance Announcement

Faber & Faber announce a new series of books, with the general title "Technology Today and Tomorrow", edited by Dr P. F. R. Venables, Principal of the Birmingham College of Technology.

The series is designed for the student and professional scientist and technologist. It has been planned to help the specialist take account of the economic, social, political, and philosophical implications, and consequences of his work and influence in society at large. All the titles have been specially commissioned, and they cover a wide range of general studies, from the development of ideas and values to the study of the social and economic conditions which have influenced, if not determined, innovations in science and technology.

The first six titles, one or more of which will appear in the next twelve months, are:

1. *Technology, Design and Aesthetics*, by R. H. Litherland, Head of the School of Art, Royal Technical College, Salford.
2. *A Social History of Engineering*, by A. F. Burstall, Professor of Education in the University of Sheffield.
3. *A History of Mechanical Engineering*, by W. H. G. Armytage, Professor of Mechanical Engineering, and Director of the Stephenson Engineering Laboratories at King's College, University of Durham.
4. *A History of Electrical Engineering*, by Dr P. Dunsheath, C.B.E.
5. *Man and Society: Readings in Moral, Political and Social Philosophy*, edited by P. H. Nowell-Smith, Professor of Philosophy, University of Leicester.
6. *The Professional Technologist*, by Dr P. F. R. Venables.

Brief Note

Adventures in the World of Science

By Charles G. Abbot (*Washington, D.C., Public Affairs Press, 1958, vii+149 pp., $3.50*)

Dr Abbot was Secretary of the Smithsonian Institution in Washington, D.C., from 1928 to 1944, and has been a Smithsonian Research Associate since 1944. This is an autobiographical account of his career as a scientist. He describes his years at the Institution, his association with early research in solar energy, and with the experiments of famous scientists of the past sixty years. He also gives us his impressions of the U.S. Presidents, Grover Cleveland, William McKinley, Theodore Roosevelt, Herbert Hoover, and Franklin D. Roosevelt, whom he knew personally. The book concludes with some remarks on Dr Abbot's latest findings on the potentialities of solar energy and weather forecasting.

PIERRE CURIE (1859–1906)

Specially drawn for DISCOVERY by Frank Horrabin.

The story of Pierre Curie is unique in the annals of scientific discovery. Indeed, it would be difficult to find a parallel to the collaboration between Marie and Pierre Curie in any field of human activity. Science, certainly, can offer no other instance of husband and wife conducting investigations of such far-reaching importance, in which the work was shared so evenly between them that the individual contributions of a trained physicist and a skilled chemist were indistinguishable.

Pierre Curie, the son of Eugène Curie, a physician, was born in Paris a century ago on May 15, 1859. He studied at the Faculté des Sciences at the Sorbonne, and in 1878, at the age of nineteen, became assistant teacher in the Physical Laboratory. In 1882 he was appointed Chef des travaux pratiques at the municipal École de Physique et chimie industrielles, and in the following year, assisted by his brother Jacques, he discovered the piezoelectricity of crystals.

In his thesis for the degree of Doctor of Science in 1895 he dealt with the magnetic properties of bodies at various temperatures, and made the important discovery that at certain temperatures ("Curie points") many bodies spasmodically change their magnetic properties.

In 1895 he was elected to the chair of physics at the Municipal School, and in the same year married Marie Sklodowska, a senior student at the school. For a time Madame Curie pursued her independent researches in her husband's laboratory, but before long they began their classic joint investigations into radioactivity.

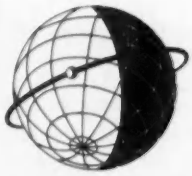
In 1896 Henri Becquerel accidentally noted that uranium emitted radiations which were capable of affecting the silver compounds contained in the photographic film, and it was this finding that inspired the Curies to begin their painstaking work which culminated in the discovery of radium and polonium—so named by Marie Curie in memory of the land of her birth. The isolation of radium was first announced in *Comptes Rendus de l'Académie des Sciences*, 1898, vol. 127, pp. 175–8, 1215–17, in a communication entitled "Sur une substance nouvelle radioactive, contenue dans la pechblende".

In the course of their researches the Curies found that uranium possesses an atomic property in which lies its power to emit rays; that this property is shared by thorium; and that certain minerals are three or four times more active than uranium—an observation which led to a search for the unknown substance which possessed such great power. One mineral, pitchblende, was particularly intriguing, and its activity was shown to be four or five times that of the total amount of pure uranium which it contained. As pitchblende contains most of the common and a number of the less common elements, their separation and the examination of each fraction proved a laborious task. In addition to the usual chemical methods of analysis the Curies used delicate electrical apparatus. The first success came with the separation from pitchblende of a substance with much greater activity than that possessed by uranium —polonium. In December 1898 followed the discovery of yet another substance which, after months of intensive effort, had been separated from the barium obtained from pitchblende. This substance, which was to be of far greater importance than polonium, was named radium. In their later work the Curies were concerned mainly with studying the properties of radium and its transformation products. In the course of these investigations they discovered the induced activity which radium confers on surrounding objects, and proved that, even after passage through a sheet of metal connected to earth, the penetrating radiations continue to transport negative electricity. The Curies steadfastly refused to draw any material profit from their discovery; they kept no detail secret; they took out no patent.

In 1903, the year in which they shared the Nobel Prize for physics with Henri Becquerel, they were further honoured by the award of the Davy Medal of the Royal Society. Pierre Curie became the first occupant of the specially created chair of physics at the Sorbonne in 1904, and in the following year he was elected a member of the Academy of Sciences. A modest, simple man, he was killed in a street accident at the comparatively early age of forty-seven on April 19, 1906.

Madame Curie succeeded her husband in the chair of physics and published her classic "Traité de Radioactivité" in 1910. She was awarded the Nobel Prize for chemistry in 1911.

GEOPHYSICS AND SPACE RESEARCH



By ANGELA CROOME

FIG. 1. *Shaping Future Research in Antarctica.* Important decisions bearing on future scientific research in the Antarctic were made at a meeting in Canberra of the Special Committee on Antarctic Research (SCAR) in March. Twelve nations are represented on the committee. The President of SCAR, General G. R. Laclavere of France (*left*), discusses a document with the Australian Vice-President, Prof. K. E. Bullen (*centre*) and Secretary, Dr G. de Q. Robin (United Kingdom).

The British National Committee on Space Research held its first meeting on March 4. Its members are:

Prof. H. S. W. Massey, F.R.S.* (Chairman)
(IUPAP representative to COSPAR)
Sir Lindor Brown, Secretary R.S.*
Prof. W. V. D. Hodge, Secretary R.S.*
Dr H. G. Thornton, R.S. Foreign Sec.*
Prof. D. R. Bates, F.R.S.*
Sir Edward Bullard, F.R.S.*
Prof. W. R. Hawthorne, F.R.S.*
Prof. F. Hoyle, F.R.S.*
Prof. A. C. B. Lovell, F.R.S.*
(IUSR representative to COSPAR)
Dr L. R. Shepherd*
Dr R. v. d. R. Woolley, F.R.S.
Dr H. A. Brück
Sir Graham Sutton, F.R.S.
Mr M. O. Robins
(U.K. delegate to COSPAR)
Dr A. H. Cook
Prof. W. J. G. Beynon
Sir Arnold Hall, F.R.S.
Dr R. L. Smith-Rose
Mr P. D. Greenall
Sir Owen Wansbrough-Jones
Sir George Gardner
Dr R. C. Cockburn
Dr A. W. Lines
Prof. P. A. Sheppard
Air Commodore W. K. Stewart
Mr R. N. Quirk
Mr. I. Maddock
Dr J. S. McPetrie

* Indicates a Royal Society member. The other members represent a variety of other interests.

Important Developments at COSPAR

The two outstanding features of the second meeting of COSPAR (CO-mmittee for SPA-ce R-esearch) that took place at The Hague from March 12–14, were the American offer to accommodate other country's experiments aboard U.S. satellites and the setting up of a successor to CETEX.

The terms of the American invitation to the other COSPAR members (ten countries are involved) are to accommodate single experiments as part of larger payloads *or* to launch one complete payload weighing between 100 and 300 lb. into a satellite orbit between 200 and 2000 miles above the Earth. It is envisaged that the COSPAR satellite experiments would not be ready to fly for a year and a half, by which time larger booster rockets should be available to lift the considerable payload suggested into orbit. Member countries are referring the offer back to the interested scientists through their principal scientific academies. The U.S. civilian space agency NASA will presumably act as the final editing authority for the foreign experiments put forward through COSPAR.

A new *ad hoc* committee or fact-finding group was established during this meeting to follow up the work of CETEX, the forerunner of COSPAR which was specifically concerned to ensure an appropriate sequence of experiments in extra-terrestrial exploration so that contamination —by either living organisms or radioactive material—of terrestrial origin did not confuse observations of the new environment, a planetary atmosphere for instance. This new committee is to study the possibilities of changes in the higher fringes of the Earth's atmosphere and the nearer region of space that may result from the explosion of atom-bombs and the release of chemical markers in high-altitude research. The Earth's upper atmosphere is almost as much an "unknown" as the atmosphere and environment of other planets and is in much more immediate danger of "contamination". In view of the disclosure of Project Argus, the explosion of three nuclear devices above 300 miles high by the U.S. last autumn, this move by COSPAR seems timely.

Van Allen Radiation

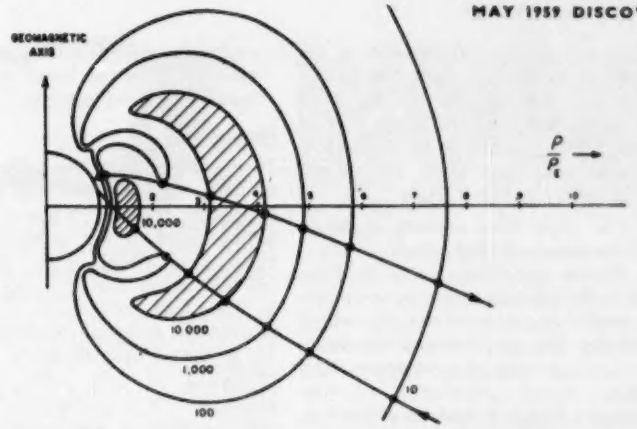
The Americans' second successful space probe, that launched by the U.S. Army at the beginning of December, provided much additional data on the Van Allen high-intensity radiation belt first detected from the *Explorer* satellites. A detailed account and preliminary interpretation of the latest findings appeared in the February 14 issue of *Nature* over the names of Prof. Van Allen and Louis A. Frank,

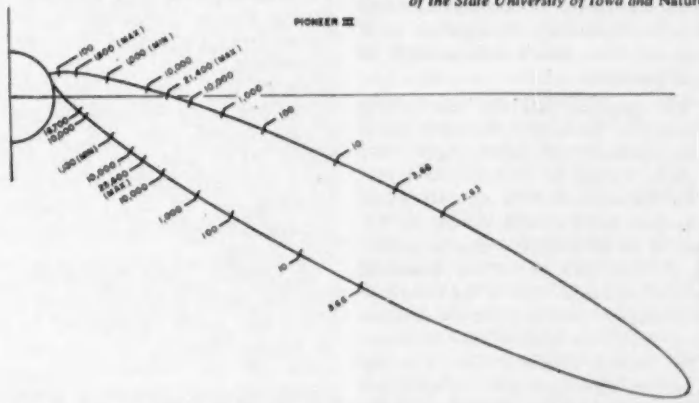
an undergraduate assistant of his at the State University of Iowa. (For previous discussion of this radiation see DISCOVERY, 1958, vol. 19, No. 10, p. 435.) It now appears that there are two layers of radiation at height above the Earth, one (that already studied by the *Explorers*) with peaks between 1400 and 3400 miles from the Earth's surface, the other and deeper zone falling between 800 and 12,000 miles out. Fig. 2 shows these zones in cross section. The structure and alignment of the zones are governed by the Earth's magnetic field which traps the particles and then prevents their escape, thus forming the generally horseshoe-shaped high-intensity zones centred on the geomagnetic equator. It will be seen that tongue-like regions of radiation extend downward toward the Earth at high geomagnetic latitude both north and south; these had first been noticed on the plot of the readings from *Explorer IV* (1958 ε). It is significant that the earthward ends of the low intensity gap between the zones seem to coincide with the region of the auroral zones. The *Pioneer* data suggests that the outer zone is that more intimately related to normal, high-latitude aurorae.

On the 38-hour flight of *Pioneer III* between December 5 and 7, the rocket passed right through both zones and emerged beyond in the region where the radiation falls to the level of the cosmic rays. The flight is shown in cross section in Fig. 3. First-class telemetry on both legs of the flight enabled the position of the zones to be plotted with some confidence. (Unreliable telemetry frustrated the radiation experiment in *Pioneer II*.) The measuring instruments in the probe were two Geiger-Müller counters with different counting rates. (The payload available for the radiation experiment was 3 lb.) It will be seen that a maximum of 25,600 counts/sec, was registered on the flight.

It is believed that both inner and outer radiation zones are semi-permanent features. The satellite 1958 ε data continued throughout a two-month period (all August and part of July and September) and no significant change was detectable. It is expected, however, that both radiation level and the structure of the zones will fluctuate considerably with the eleven-year solar cycle—in other words that they are closely associated with solar activity. It may be that the intensity structure may fluctuate on a much shorter time-scale; measurements made so far have been neither numerous nor detailed enough to say.

The origin of the radiation is still unclear. It is now suggested that the inner and outer zones may have different physical causes. It may be that the outer zone is due to particles from the Sun and the inner one to cosmic-ray albedo (as suggested by the Russians and Prof. Fred Singer), for instance. Prof. T. Gold has suggested that the determining factor may be inhomogeneities in the Earth's field acting upon material thrown out by the Sun. (Preliminary accounts of the data from *Pioneer IV* tends to discount this hypothesis.) An energy spectrum of the radiation should clear up the matter. In particular the relative contribution to the radiation of protons and electrons would be most revealing. A satellite in a pole-to-pole orbit would help to determine the structure of the radiation zones very much more precisely and especially if the orbit was highly elliptical. It seems that the *Discoverer* satellite launched by the Air Force from their new rocket base at Vandenberg Field, California, on February 28 was designed to do this.





FIGS. 2 and 3. Numbers indicate counts per second registered by the Geiger tubes; in Fig. 2 as contours of similar intensity, in Fig. 3 as actual counts recorded.
(Diagrams reproduced by courtesy of Prof. J. A. Van Allen of the Department of Physics of the State University of Iowa and Nature)

Russian Views: Earth's "Corona"

The principal points of the discussion of the radiation zones by Russian workers, which appeared in the March 6 issue of *Pravda* and the March 9 issue of *Izvestia*, are given here.

(1) S. Vernov and A. Chudakov, who have been responsible for the cosmic-ray instrumentation in the *Sputniks* and in January's space probe (*Lunik*), write in *Pravda* that radiation intensity was plotted by the latter's instruments to a distance of 90,000 miles from the Earth.

"The Soviet space rocket took off when the Sun was in a relatively calm state. In such circumstances the road for future space voyages is open. The intensity of cosmic rays at great distances from the Earth is negligible. Only two particles pass through 1 cm.^{2}/sec. It must not be forgotten, however, that explosions do occur on the Sun, even though they are few and far between. Then the Sun becomes a source of cosmic radiation and the entire solar system is filled with lethal rays."

(2) Vernov and Chudakov find that the radiation in the two zones surrounding the Earth differs greatly in composition. The electrons of the outer zone possess energies which are relatively small. In the inner zones the particles are mainly of high energies. "There are good grounds for assuming that these high-energy particles are protons."

(3) Leakage rate: "At a height of 15,000 km. (about 10,000 miles) there are 700 times more particles than at a height of 400 km. (250 miles)—on the same geomagnetic force-line. This

means that of the 700 particles at the height of 15,000 km. only one travels down to a low altitude. All the other 699 spiral back and forth along lines of force, passing from one hemisphere to the other and back again, and do not travel down to a low altitude."

(4) The outer zone extends as far as 50,000 km. (about 30,000 miles).

(5) Vernov and Chudakov are still inclined to attribute the radiation to cosmic-ray albedo. In association with A. I. Lebedinsky they put forward this hypothesis at last August's Moscow IGY meeting.

(6) In the March 9 *Izvestia*, Profs. I. S. Shklovsky and Krasovsky put forward a different theory of the origin of the radiation zones. They suggest that the radiation surrounding the Earth may be termed the Earth's "corona", by analogy with that of the Sun, which also consists of charged particles.

"We consider that the fast-moving electrons in this region have nothing at all in common with cosmic rays. They originate rather in the topmost layers of the atmosphere at a distance equal to several earth's radii, owing to the effect of an acceleration process occurring at these altitudes. Though we still have only a vague idea of the details of this process of acceleration, the decisive factor here is evidently the interplay of the Earth's magnetic field and the stream of fast particles (corpuscles) given off by the Sun, which bring with them 'scraps' of the Sun's magnetic field. It is the interaction of the Earth's magnetic field and the disturbing streams of solar particles and fields which we believe is instrumental in the acceleration of the charged particles that form the Earth's corona.

"Subsequently, these particles are caught in the Earth's magnetic trap. But we believe that from time to time, when solar influences are vigorous enough, this trap seems to open and in the areas adjacent to the Earth's poles, the fast-moving electrons "break through" into the lower layers of the atmosphere thus producing aurorae Consequently we now have a clearer notion of aurorae and magnetic storms, the nature of which has been a puzzle for a long time."

(7) "The particles in the first and lower zone, that above the tropics, possess higher energies. We consider that this zone may have been produced by artificial means, namely by high-altitude nuclear explosions such as that above Johnston Island on August 1 last which produced an artificial aurora visible from Samoa.

"We have carried out calculations which show that a few high-altitude explosions of this order are quite sufficient to form the lower zone of fast-moving charged particles."

Project Argus

In a striking experiment in the autumn of 1956, American scientists succeeded in producing artificial "whistler"-type radio atmospherics which confirmed a bold theory concerning their origin (DISCOVERY, September 1957, vol. 18, No. 9, p. 398). Last autumn, in an even more spectacular threefold experiment carried out in secrecy over the South Atlantic, the exploding of three atom bombs high above the Earth's atmosphere, produced artificial aurorae and artificial radiation "shells", confirming an hypothesis put forward by Mr Nicholas C. Christofilos, a Greek engineer now working at the Atomic Energy Commission's Livermore Laboratories, California. The news of this experiment which has had a mixed reception from scientists not directly involved due to the observational confusion it has caused, was first released on March 20 by *The New York Times*. It was shortly after confirmed and somewhat amplified by the U.S. Department of Defense. The following account draws on both sources.

In October 1957, Christofilos drew attention to the range of curious physical effects that might be expected to follow an atomic burst in the near-vacuum of space. Of the various effects contemplated, the most interesting promised to be the temporary trapping of high-energy electrons at high altitudes in the magnetic field of the Earth. Following the explosion, nuclei of intermediate atomic weight would be thrown off in all directions. Most of these nuclei being radioactive would subsequently decay with the release of energetic electrons and gamma rays. Most of this process of radioactive decay would take place within a few minutes. Fission fragments and their resulting electrons, both being electrically charged, would be governed by the Earth's magnetic field and would therefore travel in helical paths along the geomagnetic flux-lines. (The theory of the behaviour of charged particles in a dipole field dates back many years and needs no demonstration.) What was uncertain and a matter of great interest was the storage times of the electrons in the field—that is the amount of time it would take the charged particles to "leak" away, down into the atmosphere, where they would be lost due to collisions with air molecules. Trapping times ranging from minutes to weeks were estimated for electrons whose helical paths ranged from 100 miles to 2000 miles of the Earth's surface. When the "natural" Van Allen "shells" of trapped radiation were discovered last year it was clearly necessary in such an experiment to be able to tag the artificially injected electrons to distinguish this radiation from that forming the natural background. The co-ordinated observational capacities of two artificial earth-satellites, barrages of sounding rockets fired from three distinct localities and a number of high-flying aircraft were brought to bear for thus purpose. (The second satellite, *Explorer V*, launched on August 24, failed to orbit.)

Apart from the operational experience to be gained from the project, the U.S. Armed Forces clearly had a large stake in the experiments. Results of military significance remain "classified", though it is known that the disturbance to radio communications caused by the release of this radiation has gravely worried military experts concerned with radar early-warning systems and anti-missile missiles. The nuclear devices were exploded at heights above 300 miles from five-stage rockets launched from shipboard on August 27 and 30, and September 6. They were all low-yield explosions of 1½ kilotons each (in contrast to the high-altitude test near Johnston Island on August 1, which produced the Samoan artificial aurorae previously discussed in these notes and elsewhere).

The locality chosen for the firings lay in one of the emptiest areas of the South Atlantic, at approximately 45° S and between the Greenwich meridian and 30° W. Owing to the tilting of the geomagnetic axis in relation to the geographic axis, calculations showed that in this area the artificial radiation shell would be held at its closest to the surface.

Conclusions that have already been drawn from the experiment are:

(1) There was no diffusion of electrons transverse to the electron shell, since the thickness of the shell remained constant throughout the observation period. Traces of the shell persisted for many days, even weeks. This disposes of one of the theories proposed to account for the Van Allen radiation.

(2) Extrapolations of the Earth's magnetic field into space which have been based on surface measurements were confirmed by the experiments. It is now possible to predict the shape and intensity of the Earth's field to distances of several Earth's radii with considerable accuracy.

It is worth noting that *Sputnik III* has throughout been in an excellent position to observe the Argus radiation. Its batteries have not yet failed, in fact it will have been transmitting data continuously for a year on the fifteenth of this month. It seems that at least initially the Argus effects were to some degree masked from the observers of other countries by the coincidence of a considerable magnetic disturbance on the morning of September 3. Its effects persisted for several days.

Films Build Tradition in Arabic World

This article is being written in Ahmadi, the Kuwait Oil Company's town, 24 miles south of Kuwait. In this tiny Sheikdom, where the locust is regarded as a luxurious addition to a diet of sour camel's milk and dates, there is no engineering or scientific tradition. Although the town Kuwait has been bulding dhows for hundreds of years, the Bedouin has lived, and still lives, a primitive nomadic life. Up to the post-war period his livelihood was won from the scant growth of the desert. Now the fourth greatest supply of oil in the world is coming up from under the desert sands.

These primitive, although intelligent people, have to move forward from the Middle Ages in months, while it has taken the Western world years and centuries. When we think that in the Muslim calendar 1959 is in the fifteenth century after Mahomet, we get an idea of their state of development.

The Kuwait Oil Company Film Unit, supervised from London by Film Centre, is trying to build new attitudes and new traditions by showing the new way of life which is coming so rapidly to Kuwait. Derek Armstrong, the Resident Producer, says that besides training an Arab unit, his films are designed to show that some of the "Shame Trades", such as metal work, are necessary and interesting.

The first full-scale film they have made is *One Hand*, directed by Rodney Geisler, camera John Sharples, and commentary and assistant direction by a young Palestinian Arab. The title is taken from an Arab proverb which says that teamwork should be like the fingers of one hand.

The film, which is in colour, tries to show the whole scope of oil production and how the Arab, as he learns the necessary scientific and technical skills, is rapidly taking over jobs at all levels. It shows the training which changes illiterate desert Arabs into skilled tradesmen, and the use which is being made of educated Kuwaitis.

The film is interpreted in simple terms and is comparatively slow-moving, so that even those who are not used to the film medium can get the message. In Arab society after the sheikly caste, the merchant class is the most important. The film wants to show, and in the opinion of your reviewer, does, that there must be an intelligent pride in skilled trades. It sets out to build up the future importance of an artisan class with high standards. It wants to stimulate the imagination of young people, to show them that white-collar jobs are not the only ones which matter. There is satisfaction in advanced technology and science.

The "Shame Trade" problem is an extraordinary one. It is almost impossible to get the Kuwaiti to train as a carpenter, but anything to do with cars is completely acceptable. Because the car is a symbol of power and importance, so to fill its tank with petrol, or to repair its insides, or to drive the heaviest lorry is to get well up on the social scale.

This film, and others which the Unit will make, is to be shown throughout the Arab world to demonstrate what is being done by the Company to train, develop, and integrate Kuwaiti workers into the Company's activities at all levels. The film will be shown in cinemas and to Company visitors, but it will also be shown with a very definite aim in view in the very modern Kuwait schools. It will give vocational guidance to the youngsters. Its purpose is to give prestige to technical jobs, to engineering and science. This is important, as it will tend to counteract their ambitions to become lawyers or administrators.

Kuwait is still largely a tribal society, with the Sheik as the father figure. Therefore one of the objects of the film is to tell the true story of the Company acting with the Sheik and people to develop a new artisan class. Oil under their soil is a gift from Allah, and it is the job of the Kuwaitis to develop this gift and at the same time to develop the sheikdom.

This is an ambitious task for any film to do, and quite naturally the film does not do it completely, but in fulfilling a very definite and clearly defined communication and Public Relations function, it is extremely worth while. It should do quite a lot in this campaign to show the people what *their* oil industry is and what the people who make the oil flow do. The stress all the time is on the Arab at work and undergoing training.

The Film Unit has also produced the first of a series of film magazines called *Mirror of Oil*. It consists of three items. The first, "Flying to Work", shows the Company plane taking Arab workers to the Northern Oil Field. It shows that, in a country where the railway is unknown, the plane is commonplace. Excellently photographed in colour, it makes one feel that one is flying. All the sounds and the sensations are reproduced from the point of view of two Arab labourers, who travel up to work on concreting a site. Again the tempo is slow and relaxed, adapted to the Arabs' thought processes; where nothing is discussed until two or three cups of hot, bitter, Arab coffee have been drunk. But it also uses the knowledge that transport to the Arab is a power symbol.

The second item is on one of the chief national sports, hawking. A Company employee demonstrates for the camera how he trains a hawk to catch the hubara or desert bustard. This will interest the Kuwaitis immensely because all of them who can afford it keep hawks, which are, as they were in Europe, a symbol of importance.

The third item concerns the delivery of a consignment of chemicals to a drilling rig. The Arab driver goes out in a giant lorry and gets bogged down in a patch of loose sand. His non-arrival is reported and a recovery vehicle sets out. The complete recovery process is shown. Once more, the object is successfully achieved. The job is shown as one requiring considerable skill and intelligence. The treatment gives a feeling that recovering a heavy vehicle needs knowledge by the man and immense power from the machine. This is a combination which gives satisfaction to the Arab mind.

Your reviewer found it most stimulating to see these films in the area where they were made, against a background of Kuwait town being reconstructed into a modern city and, not far out in the desert, encampments of dark-brown camel-hair tents and flocks of sheep and goats. Naturally these films are being made empirically, each one is an experiment, and upon success or failure future production depends.

What of future production? As far as your reviewer knows, nothing is definitely settled, but they plan to make films fitting Kuwait's oil production into the world frame, and others boosting the Kuwaitis' idea of progress. Besides these Public Relations films, they plan to make motivation and training films.

One on the work of the oil port is already being filmed. The port handles over 56 million long tons per year. A new oil pier is being built. The largest tanker in the world visited Kuwait on its maiden voyage recently. All this is being filmed and edited to show progress in the State.

They have finished scripting a film on medical rehabilitation, called *Return to Life*. Its object will be to show that men with severe industrial injuries will receive the most modern medical treatment and will be helped to reconstruct their lives.

Tankers come sailing up the Persian Gulf in their hundreds. Many crew members do not take precautions against heat exhaustion. The summer temperature

is often 120°F. About 200 sailors have died in the last seven or eight years from heat exhaustion and heat-stroke. So the Company intends to make a film explaining the danger and showing the precautions which can be taken. They also intend to make a film on kitchen hygiene which will probably be shown to convalescent patients in hospital, especially to maternity cases. There will also be showings at the clinic, and possibly in the public cinemas.

The Unit plans to allocate a percentage of its time to producing short films on training and safety. These will be integrated with flannel board material, posters and flip-over charts, and will thus make complete units. They will also be planned so that they can be understood by illiterate or semi-illiterate groups.

Your reviewer is certain that this carefully planned and well integrated programme will do much in the overall effort to bring the sheikdom into line with modern technical and scientific progress.

L. GOULD-MARKS

Nuclear Films for Euratom

After the signing of the agreement between the British Government and Euratom in February, Sir Edwin Plowden, Chairman of the Atomic Energy Authority, presented to Euratom a cabinet containing a library of British films on atomic energy.

Prof. E. Medi of Italy, the leader of the Euratom Commissioners visiting England for the ceremony, received the cabinet, together with a bound catalogue of British atomic films on behalf of Euratom. All the seventeen films contained in the cabinet were made for the United Kingdom Atomic Energy Authority and provision is made for future films to be added to the collection.

In presenting the gift, Sir Edwin hoped that this film library would prove of service throughout the community. The subjects of the films included the design and construction of the gas-cooled graphite-moderated reactor; the uses of radio-isotopes in industry, medicine, agriculture and research, and the safety aspects of atomic energy. The full list of films made for the Atomic Energy Authority is: *Calder Hall, Great Day, The Construction of Calder Hall, Engineering at Calder Hall, Heat Exchangers at Calder Hall, Reactors at Calder Hall, The Dounreay Sphere, Criticality, Metals of the Nuclear Age, Radioisotopes in Industry, A Matter of Contamination Sense, More Power from the Atom, Pituitary Implantation with Au^{198}, Exercise Mermaid, Personnel Protection in Toxic Area.*

Granada Lectures

The British Association for the Advancement of Science announces the inauguration of the Granada Lectures. This is a new series of annual lectures, organised by the British Association and sponsored by Granada TV Network Ltd, on the theme of "Communication in the Modern World". The broad purpose of the Granada Lectures is to explore the impact of communications in the field of the mass media—press, radio, television, and film—in their sociological, political, and technical aspects.

The first series of three lectures will be given in London in October 1959 and three speakers of international status have accepted invitations to deliver them.

The first lecture will be given by Sir Edward Appleton, G.B.E., K.C.B., F.R.S., Principal and Vice-Chancellor of Edinburgh University, Nobel prizewinner 1947. He will speak on the significance for society of long-range communication and the exploration of space.

The second lecture will be delivered by Mr Edward R. Murrow, the well-known American television and radio commentator and news analyst, who will speak on the impact of television and radio in the field of politics and public affairs in a democracy.

The third lecture will be given by Sir Eric Ashby, Vice-Chancellor of Queen's University, Belfast, whose subject will be methods of presenting scientific information to the man in the street and the extent to which the role played by the mass media in this field might be extended or improved.

The lectures will be delivered to an invited audience, to include representatives of science, industry, politics, education, local government, the mass media, and others. There will also be a limited number of tickets available to the public. The texts of the lectures will afterwards be published.

With each lecture will be linked a television programme, in which it is hoped the lecturer will participate, dealing with the subject-matter of the lecture in appropriate television form for a wider audience.

Further particulars will be made known in due course.

Television

Compared with the volcanic activity of February, science television broadcasting during March was relatively quiescent. For the time being, A. E. Singer's BBC series, "Eye on Research", appears to have ended. Your reviewer hopes its return will be soon, for despite occasional infelicities these programmes made a notable contribution to the televising of science. In looking back over the past eighteen programmes of this series, your reviewer feels that his comment on this series in the March issue of DISCOVERY that "the general impression left, after some time, was that of visits to large laboratories", needs modification. For, indeed, six of these eighteen programmes were pure university broadcasts and three others contained university contributions. It is to be hoped, however, that the technical jargon of the young specialist will be discouraged.

The only really significant science broadcasting during the whole month of March were two of Mr McCloy's "Science is News" programmes on BBC, and the ITA Sunday item, "It Can Happen Tomorrow". The March 5 issue of "Science is News" gave one of the liveliest and most entertaining science programmes broadcast so far. It was a serious yet light-hearted discussion on baldness, which is a joke to some but a serious matter to many. The programme was opened by Prof. Bullough, who lectures so often and with such witty charm on zoological subjects in the BBC schools broadcasts. He gave a concise, effective description of the mechanism of human hair growth and the problem of baldness. His greatly enlarged close-up of a bald head and his huge model of a hair follicle, though slightly comic, were excellent methods of illustration and were admirably used as visuals. He summed up with a lively case making out that external additives will not assist hair growth.

Then Dr Marriot, who was associated with the industrial side of hair preparations, made claims that some external applications could be of real help in the promotion of hair growth. An excellent fifteen-minute discussion followed, where Mr David Attenborough proved an able chairman: an entertaining, controversial, scientific broadcast. Somehow, biological subjects lend themselves to conflict, and Mr McCloy has not been slow to exploit this fact successfully.

There followed a short film on the bluebottle, interesting in itself, but somehow rather an odd-placed "quickie" which might as well not have been there.

The second half of the programme, introduced by Dr Margerison, was about the then current news, the arrival of a tanker carrying liquid methane for the Gas Board, a future new supply for domestic gas. The fact that the methane is transported in liquefied form was taken as an excuse for repeating what has now been seen often on television: spectacular experiments with liquid air. Although the relation between the experiments and the transportation and storage of methane was indeed somewhat remote, nevertheless liquid-air experiments are always good fun, both for lecturer and audience. Dr Margerison then gave a most competent interview with Dr Burns of the Gas Board, and some excellent film was

used to show that there was more behind the transportation and storage of liquid methane than is usually thought.

The second programme, March 19, though different, was equally interesting. Again there were two distinct subjects, one, as before, introduced by Mr David Attenborough, the other by Dr T. Margerison.

Fifteen minutes were allocated to Prof. Cohen on a study of psychological influences and probability choices in games and exercises of chance. The subject was of universal interest, for many people at one time or another hazard a bet, whether on sports results or premium bonds. The material used for illustration was attractive and richly varied, but the programme was rushed. It was worthy of half an hour on its own.

The second half of the programme, with Dr Margerison, was devoted to a brief survey of the achievements of the recent International Geophysical Year. The formidable cost and the extensive planning were well emphasised, and then the significant question posed, namely: "What has come out of it all; what has resulted from 30,000 participants in 4000 stations at a cost of £500 million?" Naturally, in the time available, only brief generalisations could be attempted, and an excellent device was used. Three separate short film interviews were shown. Dr Margerison was the questioner in each and so there was a sense of unity, as if it were a live broadcast. Such film recording is in a different class from prepared, dubbed scientific film and can justly be treated as equivalent to live broadcasting if judiciously and sparingly used. There was every justification for such film in the present instance. The first interview was with Sir Edward Bullard, who reviewed oceanographical findings. Then Dr Margerison very rapidly ran through such aspects as earth-axis wobble, Northern and Southern Lights, solar flares, sea currents; and satellites were not overlooked. The second film interview was on Arctic observation, with Dr. G. Pratt. Finally, an interview with Sir Graham Sutton, the Director of the Meteorological Office, who discussed atmospheric jet streaming and long range weather forecasting. This admirable programme ended with a discussion in which Prof. Massey and Dr Martin of the Royal Society took part. The future of international co-operation and the time lapse desirable before another IGY were under consideration.

This vivid programme was filled with a great variety of interesting, summarising information—precisely what the intelligent viewing audience requires. Your reviewer was pleased to see that "Science is News" appears to be crystallising into two fifteen-minute items. He is convinced that this is superior (although it involves more preparation) to a series of rapid short sequences.

Unless your reviewer has made an omission somewhere in scanning the programmes, it seems that science broadcasting on ITA during the whole month has been restricted to one weekly programme in the series "It Can Happen Tomorrow". This fifteen-minute programme is timed for the unusual hour of 5.50 on Sunday afternoon. Although, of course, your reviewer has no viewer statistics on the matter, it is a reasonably safe guess that this is not an adult peak-viewing time, as it follows the weekly children's "William Tell" adventure film. Certainly many children will stay put and see this programme (they stay put anyway unless dragged away) but it certainly cannot have been intended for children, since the content has an adult approach. On Easter Sunday, in the programme produced by Mr J. Watson, Mr G. Leach very ably discoursed on the virus and virus disease in so far as it affected man. He used some admirable models but did slip into some (obvious) errors and colloquialisms through insufficient emphasis of the high magnification of his models. Thus it is a little misleading when in a moment of enthusiasm the lecturer holding a model virus impacting a bacterium pulls out long string filaments to represent nucleic acid and then says "Yards and yards of nucleic acid now enter the bacterium". Your reviewer thinks a number of listeners would automatically take it that he did really mean "yards and yards", since he said so, with no further qualification. However, this is a minor criticism; what really matters is that the broadcast as a whole was excellent: vividly illustrated and well arranged. A broadcast which deserved a far better place in the time-table.

S. TOLANSKY

LETTERS TO THE EDITOR

Electrical Storage

Sir:

Your leader in the February issue on storage of electricity is, I think, a little unfair.

There has in the past been insufficient economic justification for the large capital expenditure involved in pumped storage in a country like Britain which is not mountainous. The initial demand for 80% load factor on nuclear stations has now provided justification, but one cannot help wondering whether an improvement in utilisation of nuclear fuel (and hence reduction in capital invested in fuel) will swing the balance back within ten years.

The comparison between progress in specific output of electrochemical storage devices and of electromechanical machines (generators and motors) is unfair because entirely different factors are involved. The developments in electrical machines are due to more intensive use of the gross properties of matter—raising the temperature limit on insulation and increasing the mechanical stresses—and the gross properties are notoriously many orders of magnitude worse than ideal theory would predict. Electrochemical apparatus, on the other hand, depends on atomic properties, and one might equally complain of lack of progress in fuels; the boron fuel which is not yet generally available gives only a modest increase in energy/weight ratio, nothing like the improvement in storage batteries which you demand. Such a leap forward can only come through either inspired or chance discovery, and not through the persistent effort which improves engineering techniques.

D. A. BELL, M.I.E.E.
University of Birmingham.

Earliest Films

Sir:

With reference to Mr Barclay's article on "The Earliest Films" in your October edition, I was most interested to note his comment that problems had arisen regarding the preservation of the films. The British Film Institute has recently prepared 35 mm. and 16 mm. prints of films made by Dr Marey, Birt Acres, and Robert Paul. These are proving of considerable interest amongst film historians. This material was prepared for distribution in association with the National Film Archive, who looked after the delicate technical work.

Early material of this kind is now so rare that Mr Barclay's work in indexing and preserving such items as The Opening of the Kiel Canal, and Admiralty Pier, is most welcome. Perhaps it might be possible for copies to be made available to film students.

JOHN HUNTLEY
British Film Institute.

The Science of Science

Sir:

I should be grateful if you would allow me to re-emphasise the fact that the statistical data on readership of technical journals quoted in my article "The Science of Science" (DISCOVERY, vol. 20, p. 110, Fig. 2) should be interpreted with the greatest caution. The figures are subject to memory error by the correspondent, and some errors are likely through confusion between similarly named journals.

C. SCOTT

FAR AND NEAR

The Royal Society: New Fellows Elected

BEALE, DR GEOFFREY HERBERT, M.B.E., Senior Lecturer in Genetics at the University of Edinburgh, Institute of Animal Genetics. Distinguished for his researches on the genetics of flower pigments and on nucleus-cytoplasm relations in *Paramecium*.

BERGEL, PROF. FRANZ, Professor of Chemistry in the University of London, at the Chester Beatty Research Institute of the Institute of Cancer Research, Royal Cancer Hospital. Distinguished for his work in synthetical organic chemistry in the field of vitamins and drugs.

BISHOP, DR ANN, Director of the Medical Research Council Group for Research in Chemotherapy, at the Molteno Institute of Biology and Parasitology, Cambridge. Distinguished as a protozoologist and especially for her work on the malaria parasite and its resistance to drugs.

BLACKMAN, PROF. GEOFFREY EMETT, Sibthorpian Professor of Rural Economy in the University of Oxford, Department of Agriculture. Distinguished for his research work on the ecology of wild and cultivated plants and on weed-killers.

BONDI, PROF. HERMANN, Professor of Applied Mathematics in the University of London, King's College, Distinguished for his contributions to cosmology, astrophysics, and other branches of theoretical physics.

CASSELS, PROF. JAMES MACDONALD, Professor of Experimental Physics in the University of Liverpool. Distinguished for his studies of high-energy nuclear physics using particle-accelerating machines.

CLAPHAM, PROF. ARTHUR ROY, Professor of Botany in the University of Sheffield. Distinguished for his research upon many important aspects of ecology and taxonomy, especially those relating to British plants.

CRICK, DR FRANCIS HARRY COMPTON, Member of the staff of the Medical Research Council Unit for Research on the Molecular Structure of Biological Systems at the Cavendish Laboratory, Cambridge. Distinguished for his contributions to molecular biology.

FEILDEN, MR GEOFFREY BERTRAM ROBERT, Director of Research, Ruston and Hornsby Limited, Lincoln. Distinguished for his application of scientific principles to the development and design of industrial gas turbines.

HENDERSON, DR DAVID WILLIS WILSON, C.B., Director, Ministry of Supply Microbiological Research Establishment, Porton, Wiltshire. Distinguished for his work on aerosols and the pathogenesis of airborne infections.

KEYNES, DR RICHARD DARWIN, Lecturer in Physiology at the University of Cambridge, Physiological Laboratory. Distinguished for his work on ionic movements in nerve and muscle and on the origin of the discharge in electric fish.

LE FEVRE, PROF. RAYMOND JAMES WOOD, Professor of Chemistry in the University of Sydney and Head of the School of Chemistry. Distinguished for his studies of the physical properties of organic compounds.

NEUMANN, DR BERNHARD HERMANN, Reader in Mathematics at the University of Manchester. Distinguished for his contributions to the theory of groups.

NOCKOLDS, DR STEPHEN ROBERT, Reader in Geochemistry at the University of Cambridge, Department of Mineralogy and Petrology. Distinguished for his researches on the petrology and geochemistry of the igneous rocks.

PRICE, PROF. WILLIAM CHARLES, Professor of Physics in the University of London, King's College. Distinguished for his contribution to chemical physics, especially to spectroscopy.

RAYNOR, PROF. GEOFFREY VINCENT, Feeney Professor of Physical Metallurgy in the University of Birmingham and Head of the Department of Physical Metallurgy. Distinguished for his research on the structure of metals and alloys.

RICHARDS, PROF. OWAIN WESTMACOTT, Professor of Zoology and Applied Entomology in the University of London, Imperial College of Science and Technology. Distinguished for his researches in entomology.

RICHARDS, DR REX EDWARD, Lecturer in Chemistry at the University of Oxford, Physical Chemistry Laboratory. Distinguished for his work on nuclear magnetic resonance and its application to chemical problems.

ROGERS, PROF. CLAUDE AMBROSE, Astor Professor of Mathematics in the University of London, University College. Distinguished for his contributions to several branches of pure mathematics, particularly the geometry of numbers.

SALAM, PROF. ABDUS, Professor of Applied Mathematics in the University of London, Imperial College of Science and Technology. Distinguished for his contributions to the theory of elementary particles.

SPENCE, DR ROBERT, C.B., Chief Chemist and Head of Chemistry Division, Atomic Energy Research Establishment, Harwell. Distinguished for his work on the chemistry of radioactive elements, and for his leadership of the Chemistry Division of Harwell.

TAIT, DR JAMES FREDERICK, The Worcester Foundation, Shrewsbury, Massachusetts, U.S.A. Distinguished for his work on the hormones of the suprarenal cortex.

TAIT, MRS SYLVIA AGNES SOPHIA, The Worcester Foundation, Shrewsbury, Massachusetts, U.S.A. Distinguished for her work on the hormones controlling the distribution of salts in the body.

WILKINS, DR MAURICE HUGH FREDERICK, Deputy Director, Medical Research Council Biophysical Research Unit, at the University of London, King's College. Distinguished for his contributions to the development of reflexion and interference microscopy, and for his work on the structure of nucleic acids.

WOOLDRIDGE, PROF. SIDNEY WILLIAM, C.B.E., Professor of Geography in the University of London, King's College. Distinguished for his researches on the geomorphology of south-eastern England.

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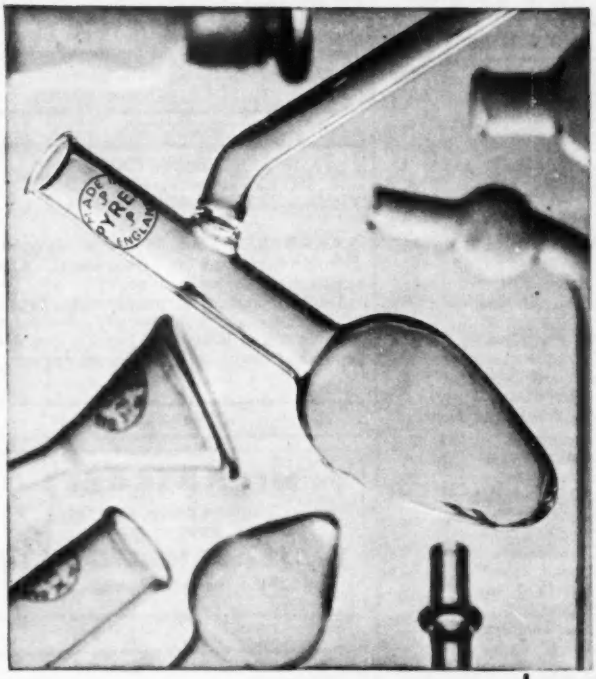
It's a somewhat smaller world



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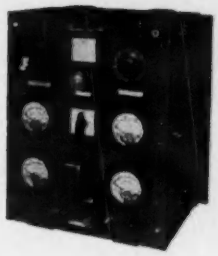

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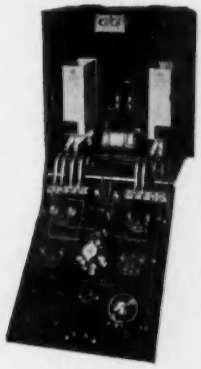

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